

2006 ENGINE

Engine Mechanical - 4.6L (1 Of 5) - Lucerne

DRIVE BELT REPLACEMENT

REMOVAL PROCEDURE

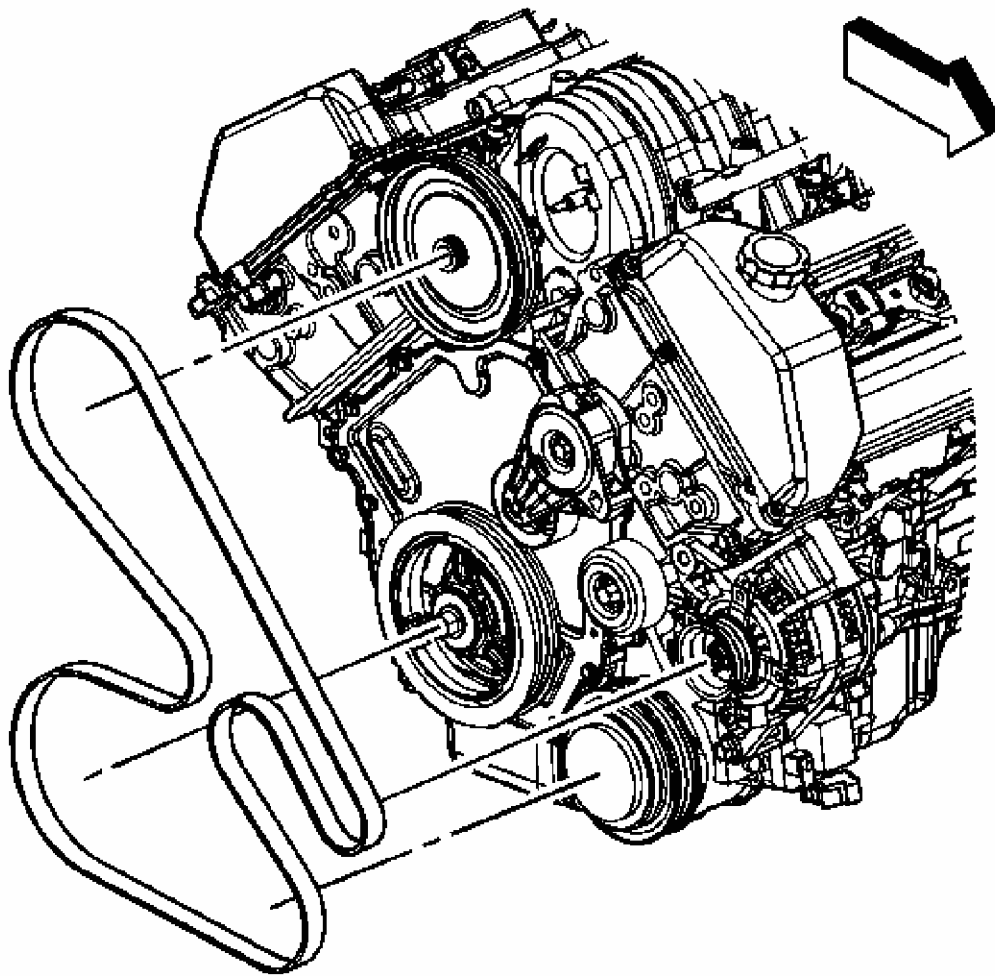


Fig. 1: Identifying Drive Belt
Courtesy of GENERAL MOTORS CORP.

1. Remove the right front wheelhouse liner. Refer to **Front Wheelhouse Liner Replacement** .
2. Install a 1/2 inch drive breaker to the drive belt tensioner.

3. Push down on the breaker bar in order to release the tension.
4. Remove the drive belt from the power steering pump.
5. Slowly return the tensioner to the original position.
6. Remove the belt from the lower pulley and idlers.
7. Partially raise the vehicle. Refer to **Lifting and Jacking the Vehicle**.

INSTALLATION PROCEDURE

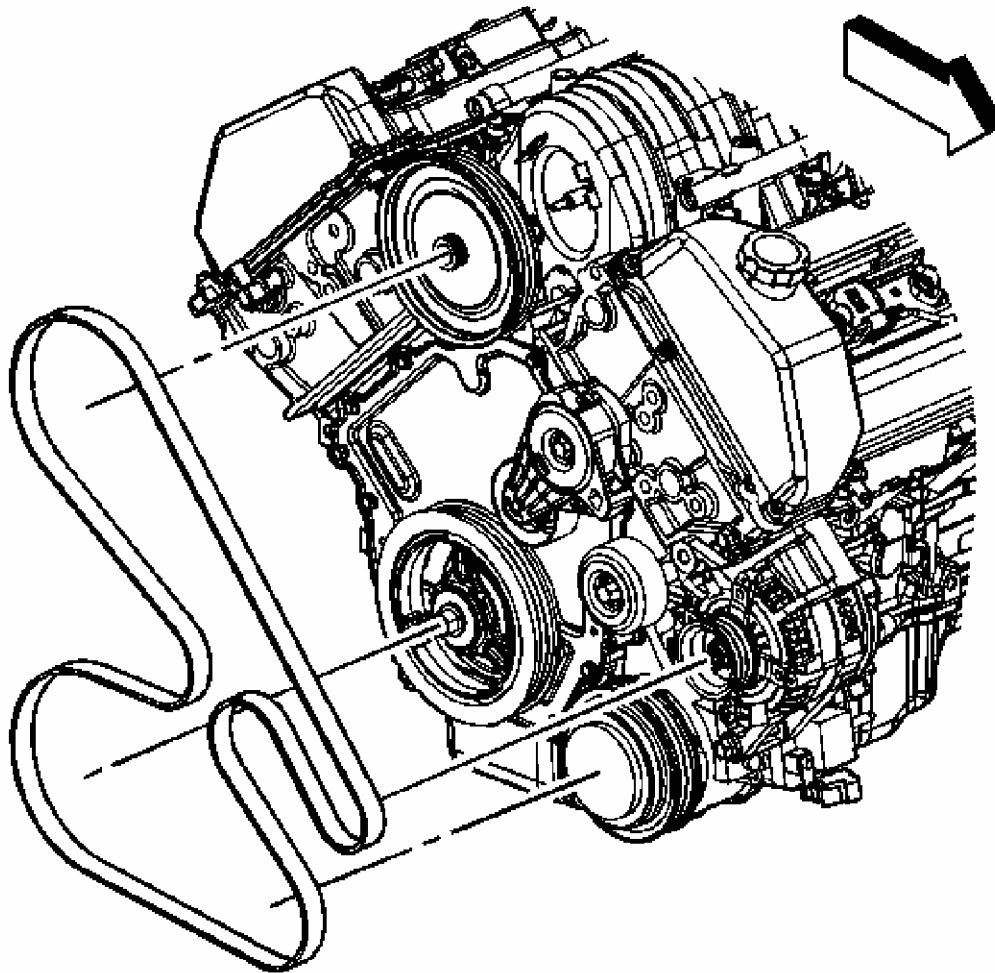


Fig. 2: Identifying Drive Belt
Courtesy of GENERAL MOTORS CORP.

1. Route the drive belt around all the pulleys except for the power steering pump.
2. Lower the vehicle.

3. Install a 1/2 inch drive breaker bar to the drive belt tensioner.
4. Push down on the breaker bar in order to release the tension and route the belt around the power steering pump pulley.

Ensure the belt is seated on all pulleys.

5. Slowly return the tensioner to its original position.
6. After drive belt installation, inspect the drive belt for the proper routing and correct alignment.
7. Install the right front wheelhouse liner. Refer to **Front Wheelhouse Liner Replacement** .
8. Start the engine and check for proper belt and accessory operation.

DRIVE BELT TENSIONER REPLACEMENT

REMOVAL PROCEDURE

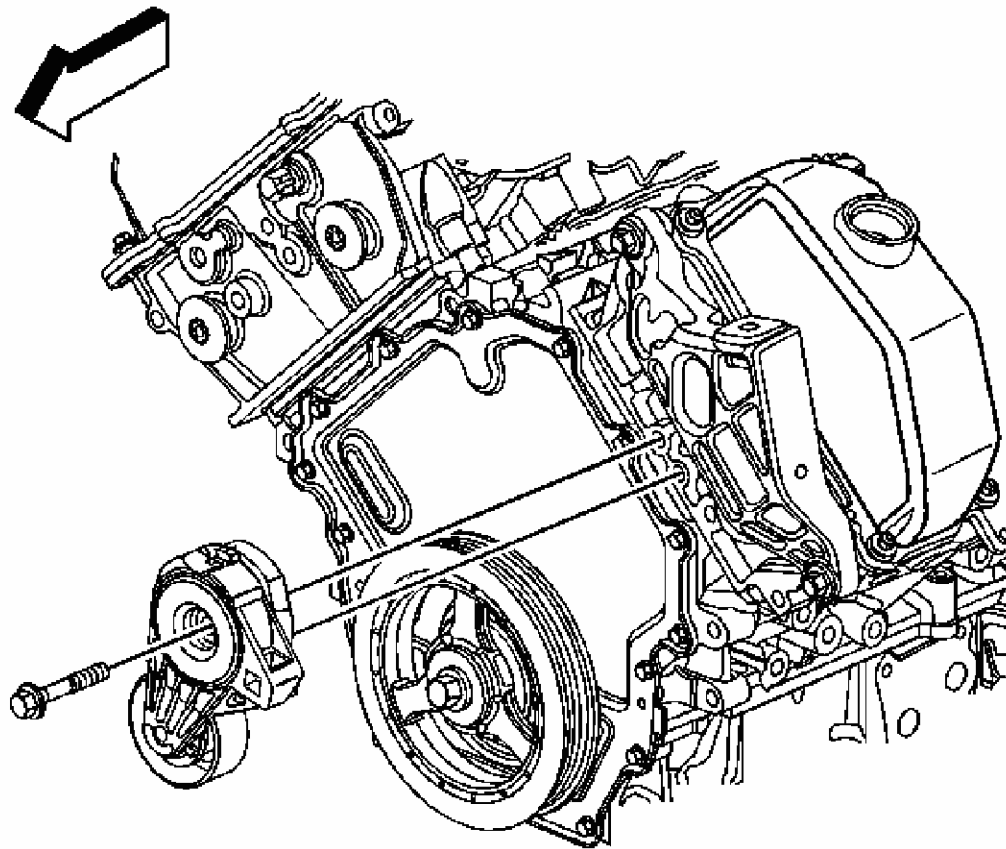


Fig. 3: View Of Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Remove the drive belt. Refer to **Drive Belt Replacement**.
3. Remove the right engine mount strut. Refer to **Engine Mount Strut Replacement - Right Side**.
4. Discharge the air conditioning (A/C) system. Refer to **Refrigerant Recovery and Recharging** .
5. Disconnect the A/C compressor suction hose from the A/C evaporator hose. Discard seal and reposition hose.
6. Remove the drive belt tensioner bolt.
7. Remove the drive belt tensioner.

INSTALLATION PROCEDURE

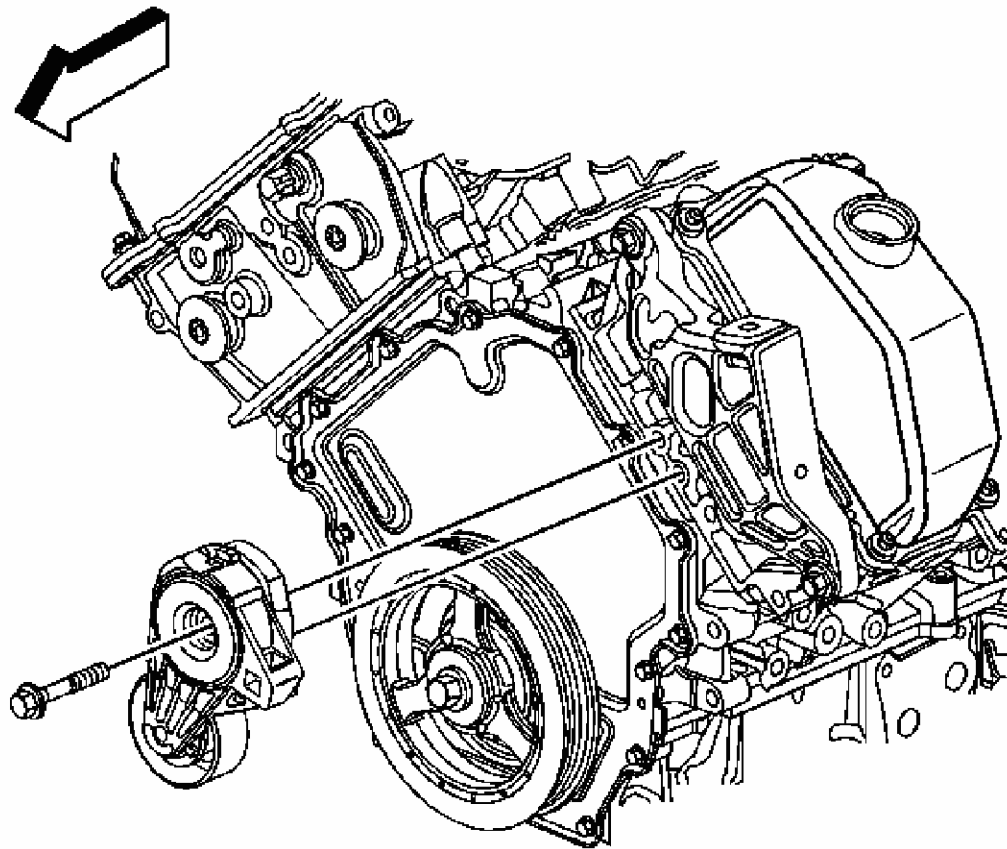


Fig. 4: View Of Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

1. Position the drive belt tensioner to the left cylinder head. Ensure the anti-rotation pin is in the hole.

NOTE: Refer to Fastener Notice .

2. Install the drive belt tensioner bolt.

Tighten: Tighten the bolt to 50 N.m (37 lb ft).

3. Install the drive belt. Refer to Drive Belt Replacement.
4. Install new seal. Connect the A/C compressor suction hose to the A/C evaporator hose.
5. Recharge the A/C system. Refer to Refrigerant Recovery and Recharging .
6. Install the right engine mount strut. Refer to Engine Mount Strut Replacement -

Right Side.

7. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

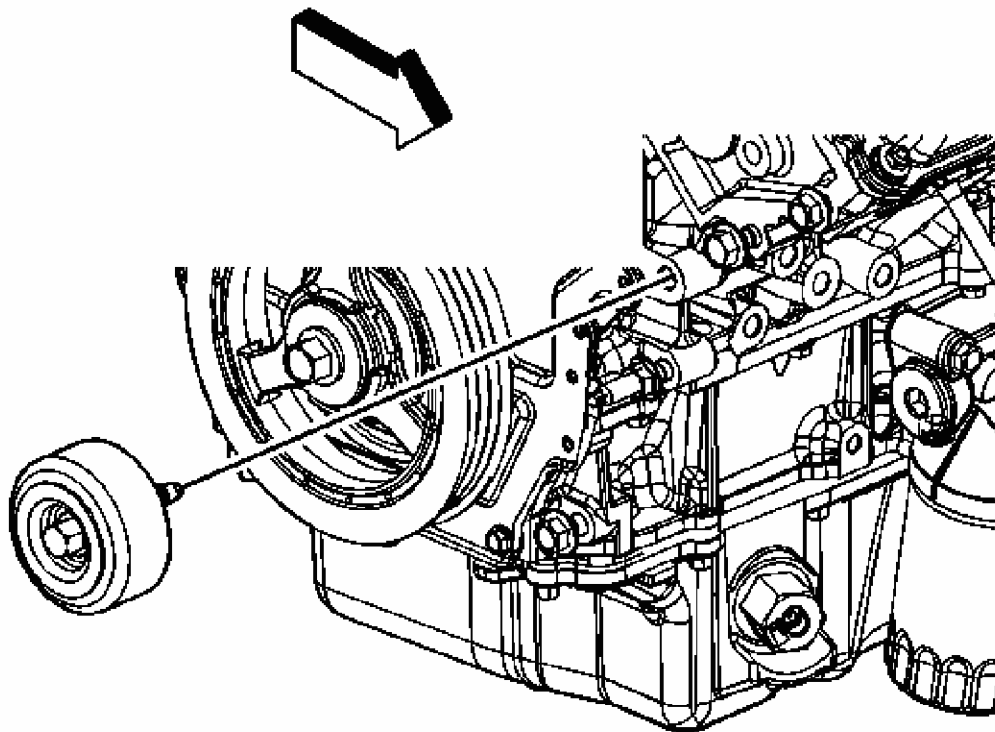
DRIVE BELT IDLER PULLEY REPLACEMENT**REMOVAL PROCEDURE**

Fig. 5: Identifying Drive Belt Idler Pulley
Courtesy of GENERAL MOTORS CORP.

1. Remove the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.
2. Loosen the drive belt idler pulley bolt.
3. Remove the drive belt idler pulley.

INSTALLATION PROCEDURE

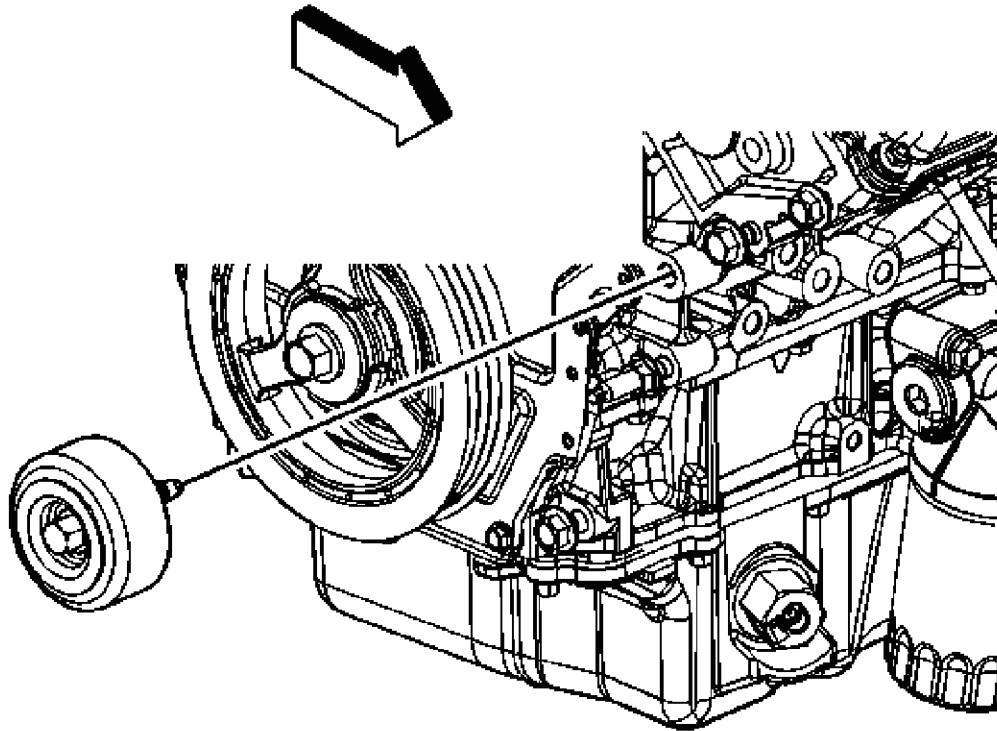


Fig. 6: Identifying Drive Belt Idler Pulley
Courtesy of GENERAL MOTORS CORP.

1. Position the drive belt idler pulley to the engine and finger starter the pulley bolt.

NOTE: Refer to Fastener Notice .

2. Tighten the drive belt idler pulley bolt.

Tighten: Tighten the bolt to 50 N.m (37 lb ft).

3. Install the drive belt tensioner. Refer to Drive Belt Tensioner Replacement.

ENGINE SUPPORT FIXTURE

TOOLS REQUIRED

- **J 28467-B** Universal Engine Support Fixture
- **J 28467-501** Engine Support Fixture Adapters

INSTALLATION PROCEDURE

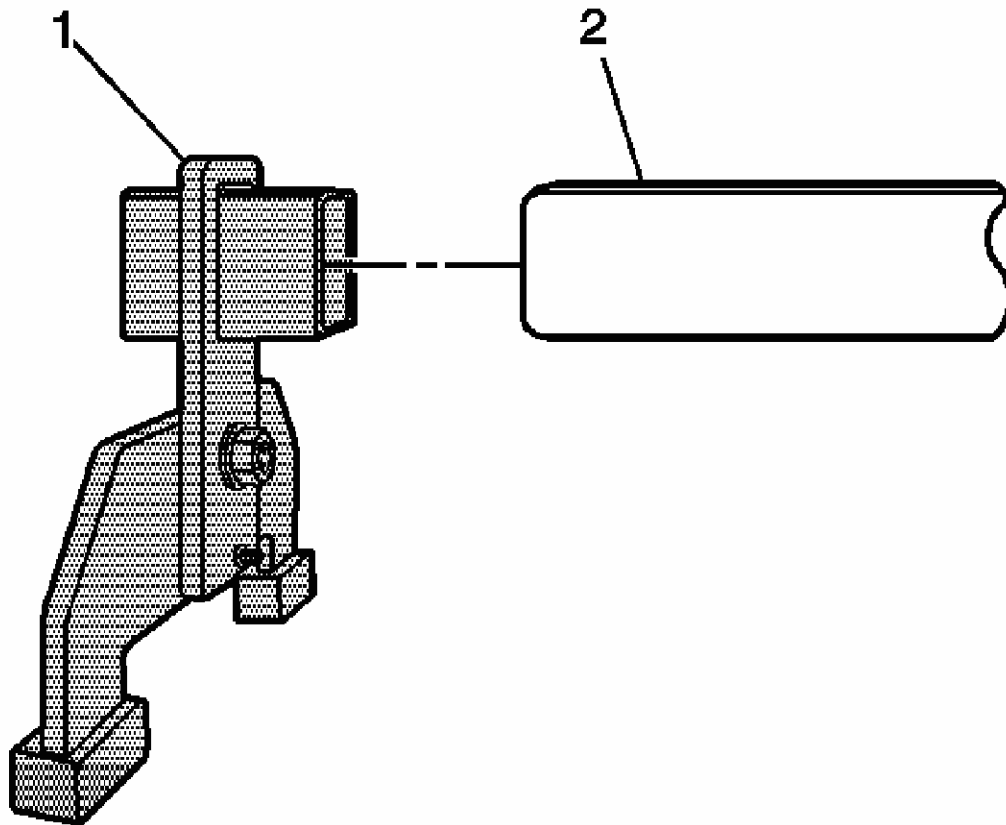


Fig. 7: Identifying J 28467-B & J 28467-3
Courtesy of GENERAL MOTORS CORP.

1. Remove the air inlet grille. Refer to **Air Inlet Grille Panel Replacement** .
2. Install the J 28467-3 strut tower tube (2) into the **J 28467-501** (1).

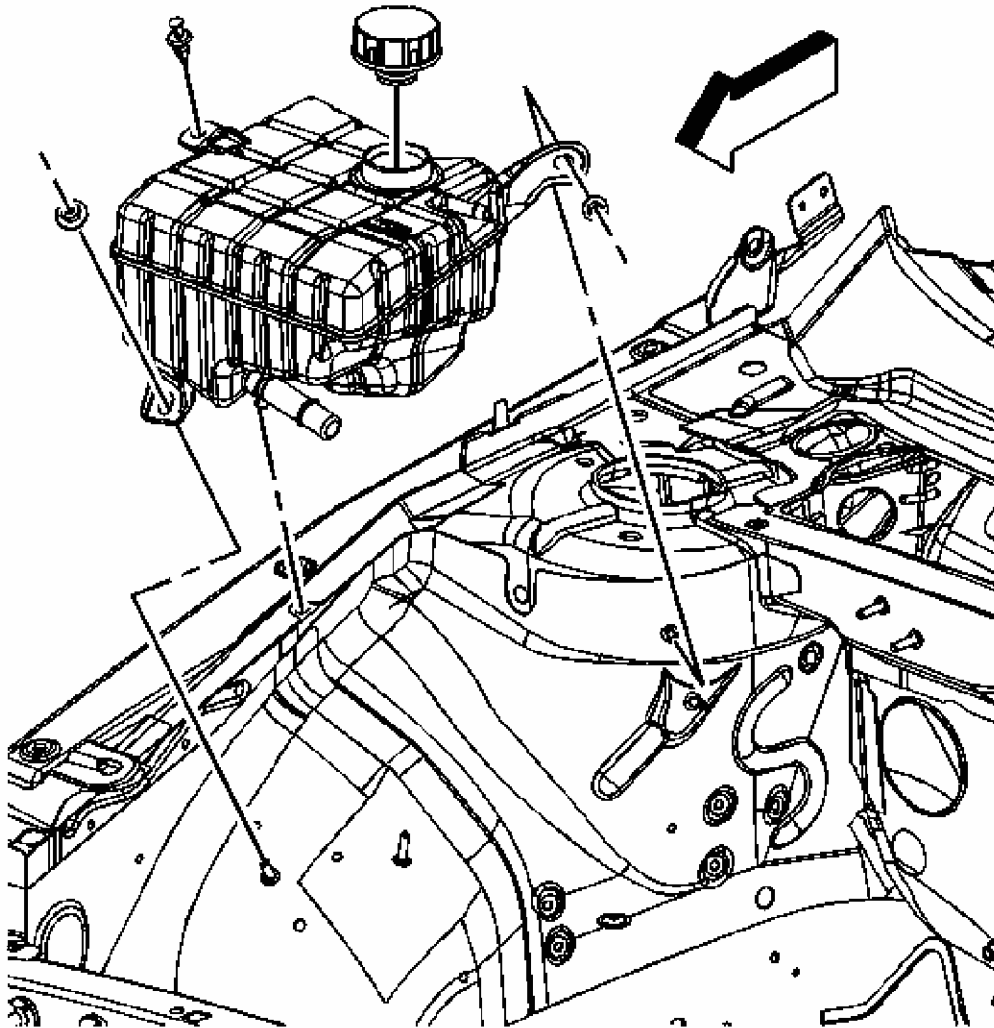


Fig. 8: Identifying Surge Tank
Courtesy of GENERAL MOTORS CORP.

3. Remove the surge tank nuts and push pin retainer.
4. Remove the surge tank from the studs and position the tank aside.

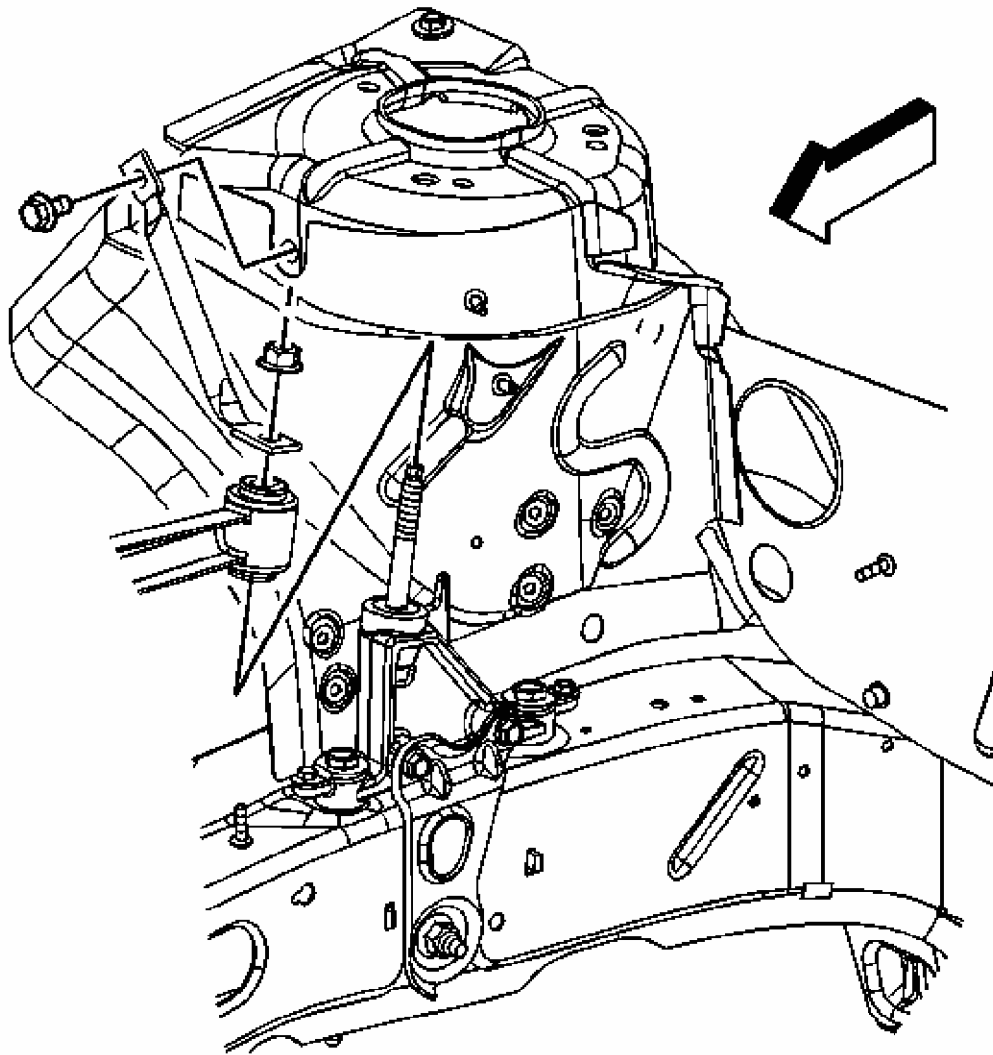


Fig. 9: View Of Engine Mount Strut Brace Bolt & Nut
Courtesy of GENERAL MOTORS CORP.

5. Remove the engine mount strut brace bolt and nut.
6. Remove the engine mount strut brace.

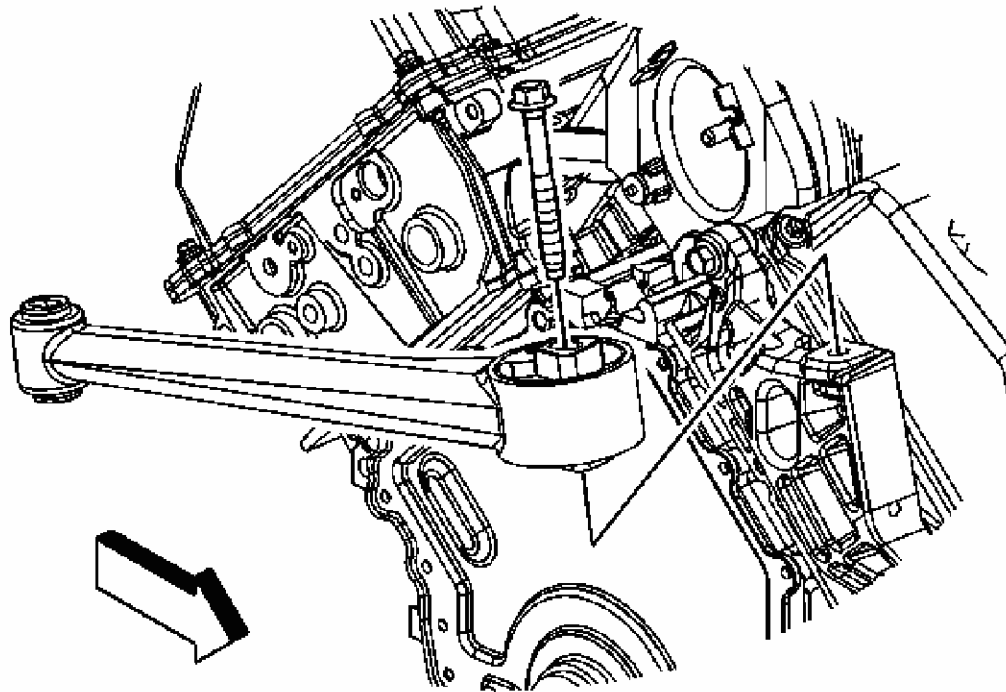


Fig. 10: View Of Engine Mount Strut
Courtesy of GENERAL MOTORS CORP.

7. Remove the engine mount strut bolt.
8. Remove the engine mount strut.
9. Remove the front compartment sight shield. Refer to **Front Compartment Sight Shields Replacement** .

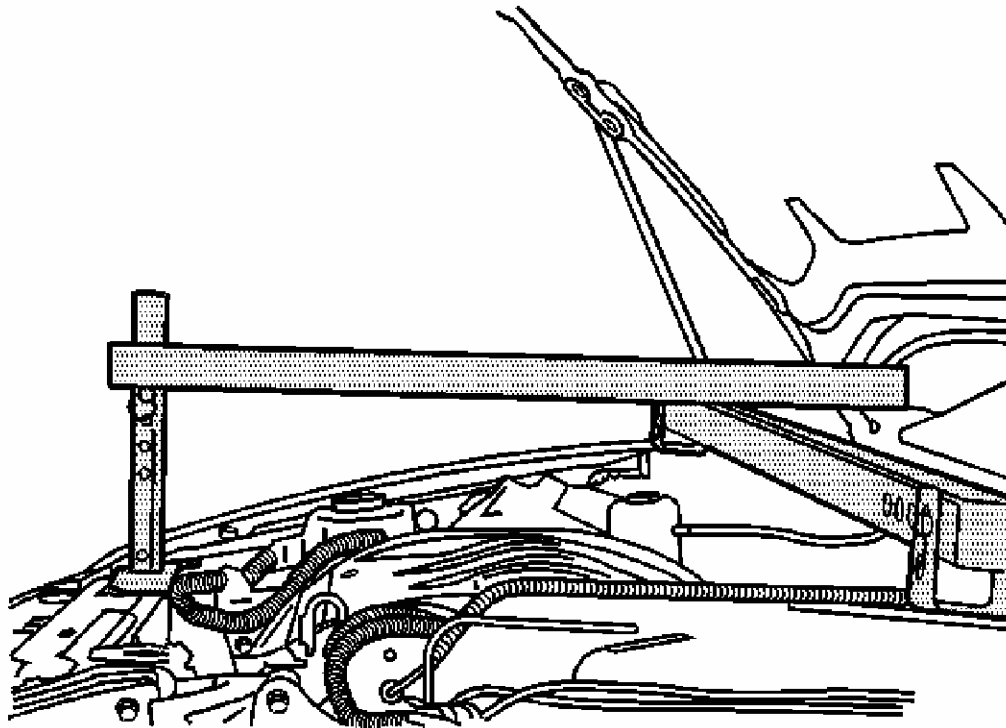


Fig. 11: View of Radiator Shelf Tube & Strut Tower Tube
Courtesy of GENERAL MOTORS CORP.

10. Install the J 28467-2A radiator shelf tube on top of the J 28467-3 strut tower tube.

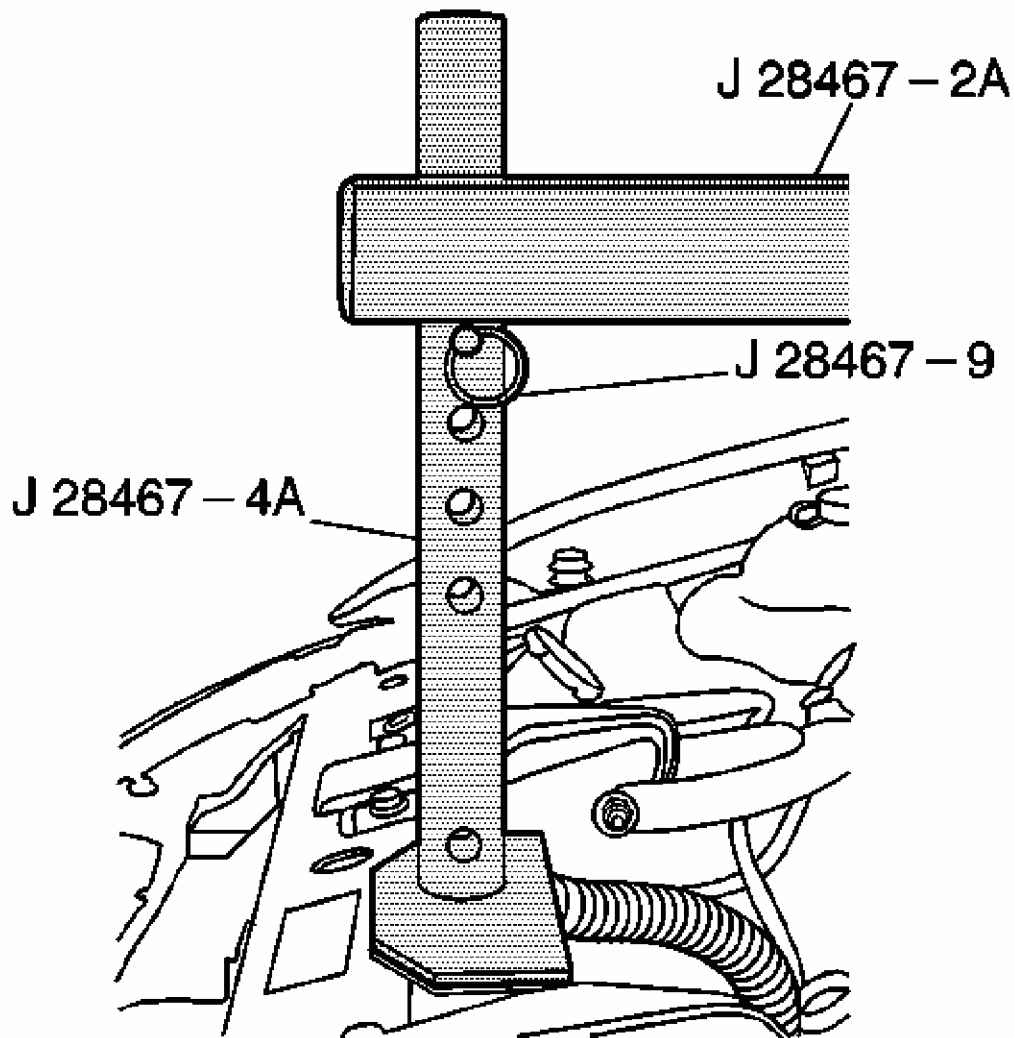


Fig. 12: Installing Quick Release Pin J 28467-9
Courtesy of GENERAL MOTORS CORP.

11. Install the round tube of the J 28467-4A front support assembly through the large hole in the J 28467-2A radiator shelf tube. The hole used in the J 28467-2A radiator shelf tube depends on the vehicle application.
12. Place the rubber padded foot of the J 28467-4A front support assembly on the upper tie bar.
13. Install the J 28467-9 7/16 in x 2.0 in quick release pin through the hole in the J 28467-4A front support assembly in order to level the J 28467-2A radiator shelf tube.

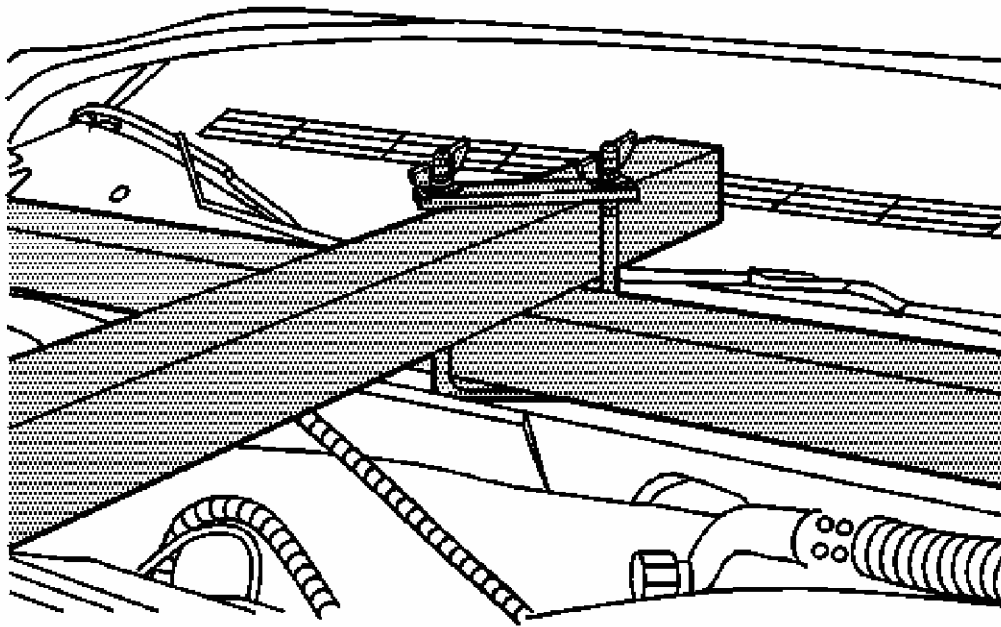


Fig. 13: View of Cross Bracket Assembly
Courtesy of GENERAL MOTORS CORP.

14. Install the J 28467-1A cross bracket assembly.
15. Hand tighten the J 28467-1A cross bracket assembly wing nuts.

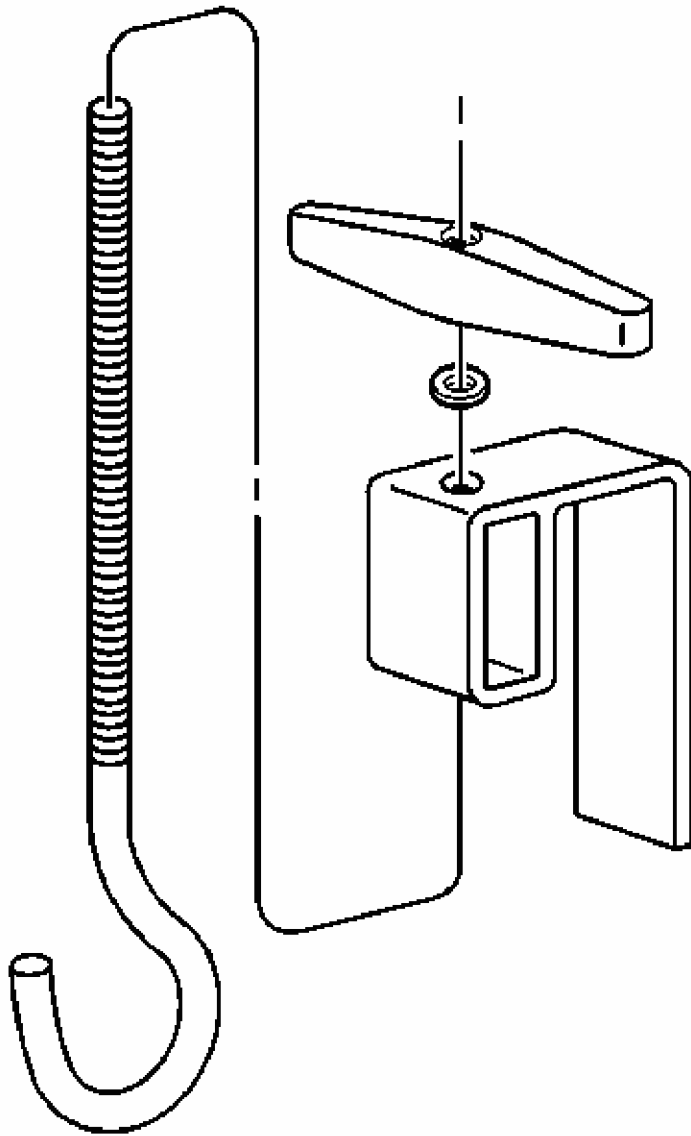


Fig. 14: View Of Lift Hook Assembly
Courtesy of GENERAL MOTORS CORP.

16. Install the J 28467-7A lift hook through the J 28467-6A lift hook bracket.
17. Install the 1/2 in lift hook washer and J 28467-34 lift hook wing nut onto the J 28467-7A lift hook.

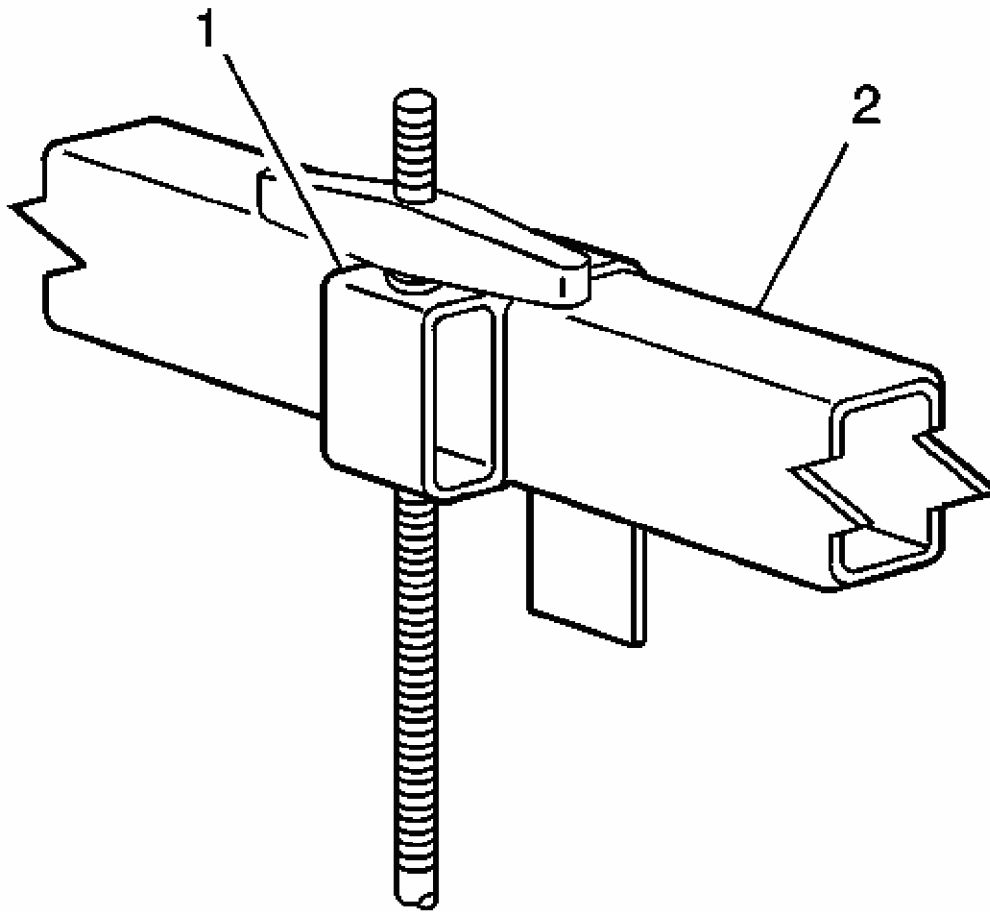


Fig. 15: View Of Lift Hook & Bracket Assembly At Longitudinal Mounted Cross Bar

Courtesy of GENERAL MOTORS CORP.

18. Install the J 28467-6A assembled lift hook bracket (1) over the J 28467-3 strut tower tube (2).
19. Adjust the J 28467-6A assembled lift hook bracket (1) in order to align the hook with the rear engine lift hook bracket.

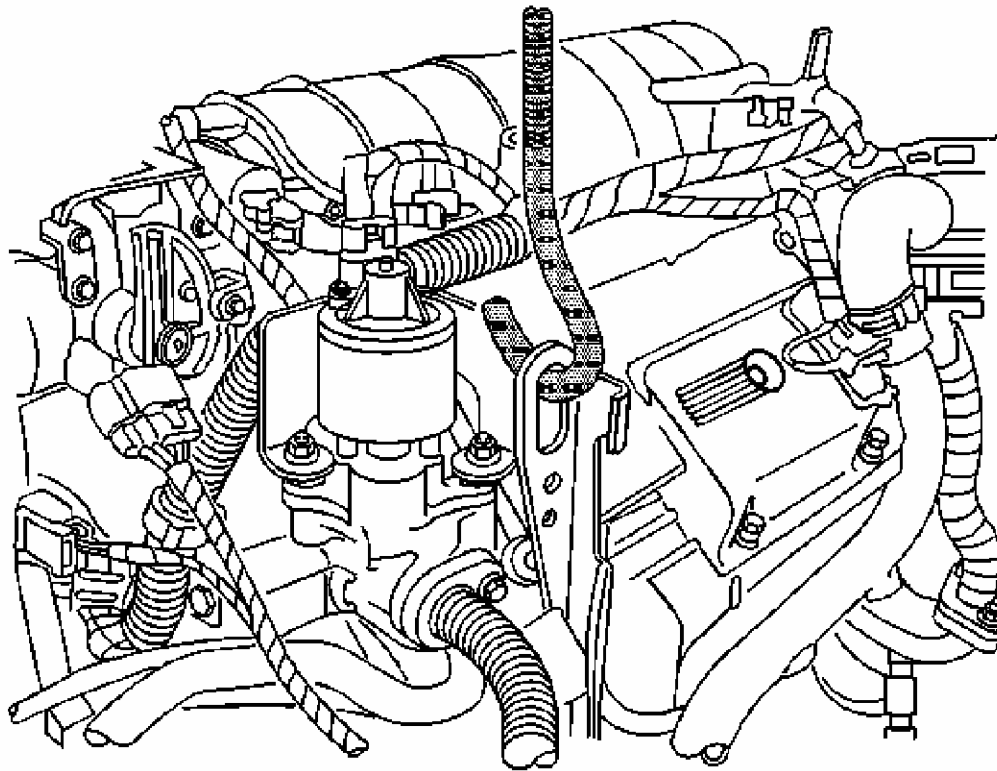


Fig. 16: Installing J 28467-7A
Courtesy of GENERAL MOTORS CORP.

20. Install the J 28467-7A lift hook through the rear engine lift hook bracket. Ensure the hook does not damage the surrounding components.
21. Repeat steps 18 and 19.

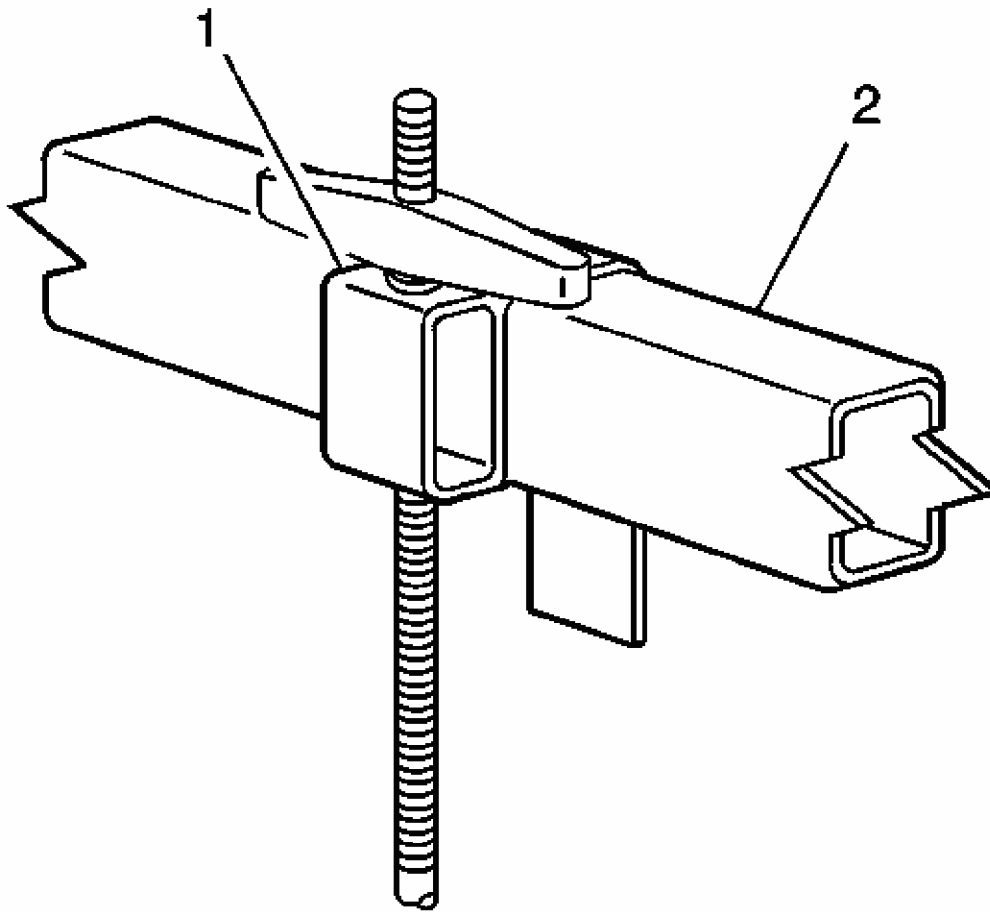


Fig. 17: View Of Lift Hook & Bracket Assembly At Longitudinal Mounted Cross Bar

Courtesy of GENERAL MOTORS CORP.

22. Install the J 28467-6A assembled lift hook bracket (1) over the J 28467-2A radiator shelf tube (2).
23. Adjust the J 28467-6A assembled lift hook bracket (1) in order to align the hook with the torque strut bracket.

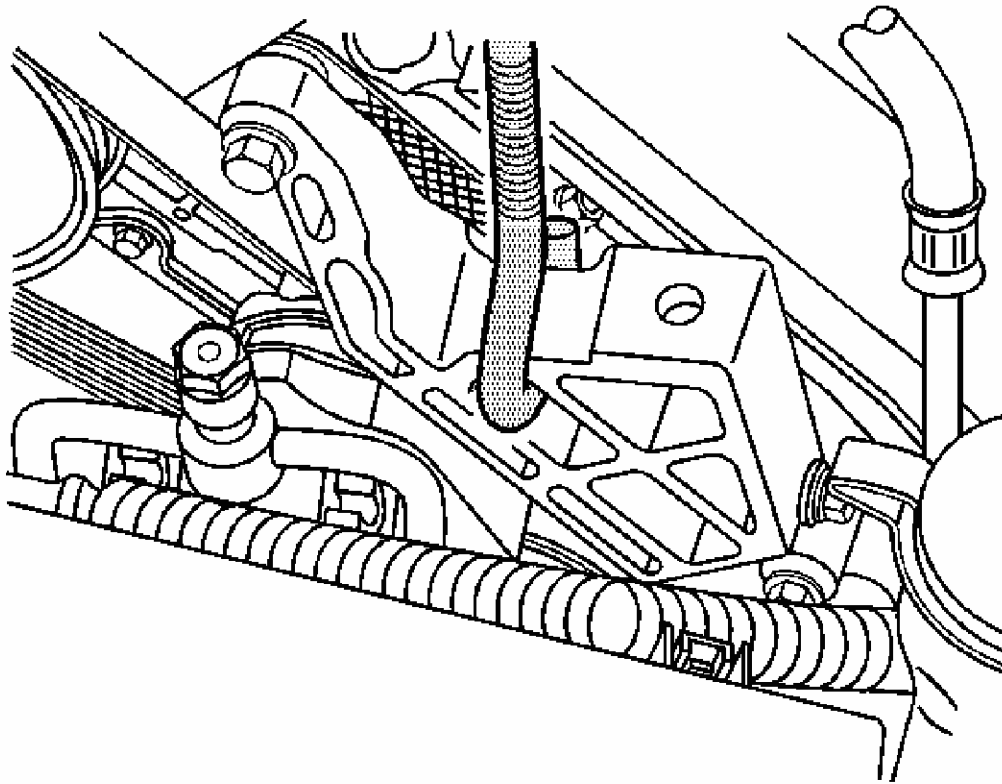


Fig. 18: View Of Lift Hook (J 28467-7A)
Courtesy of GENERAL MOTORS CORP.

24. Install the J 28467-7A lift hook through the engine mount strut bracket. Ensure the hook does not damage the surrounding components.
25. Hand tighten the J 28467-34 lift hook wing nuts securely to remove all slack from the engine support fixture assembly.

REMOVAL PROCEDURE

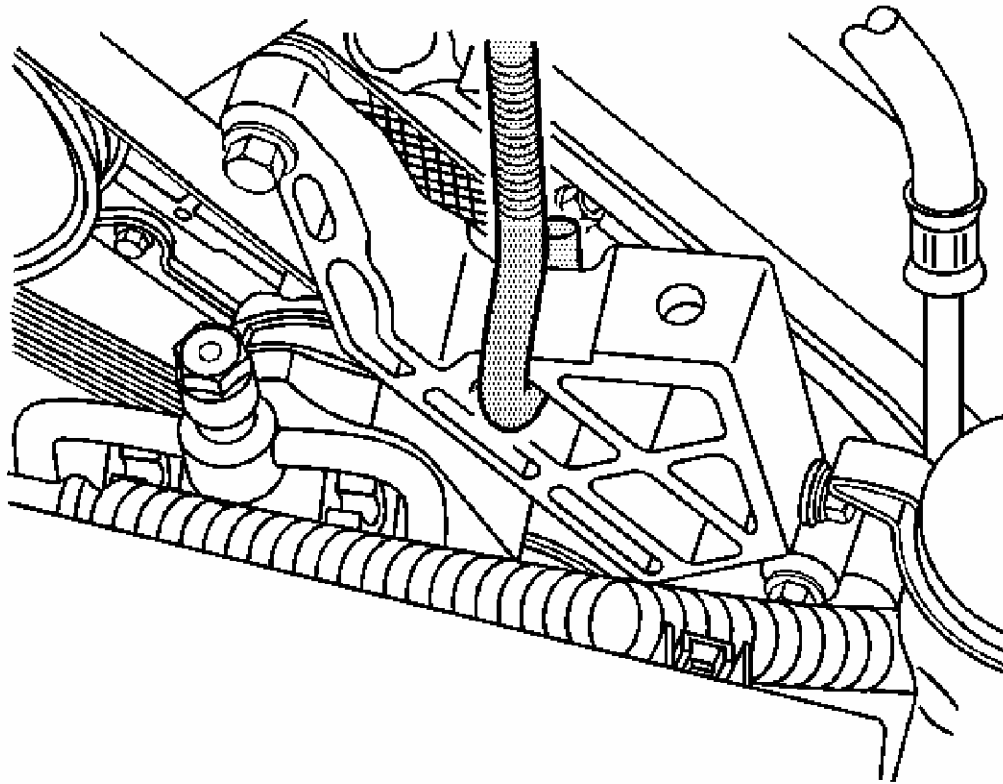


Fig. 19: View Of Lift Hook (J 28467-7A)
Courtesy of GENERAL MOTORS CORP.

1. Remove the J 28467-7A lift hook from the engine mount strut bracket.
2. Remove the **J 28467-B** .
3. Remove the **J 28467-501** .

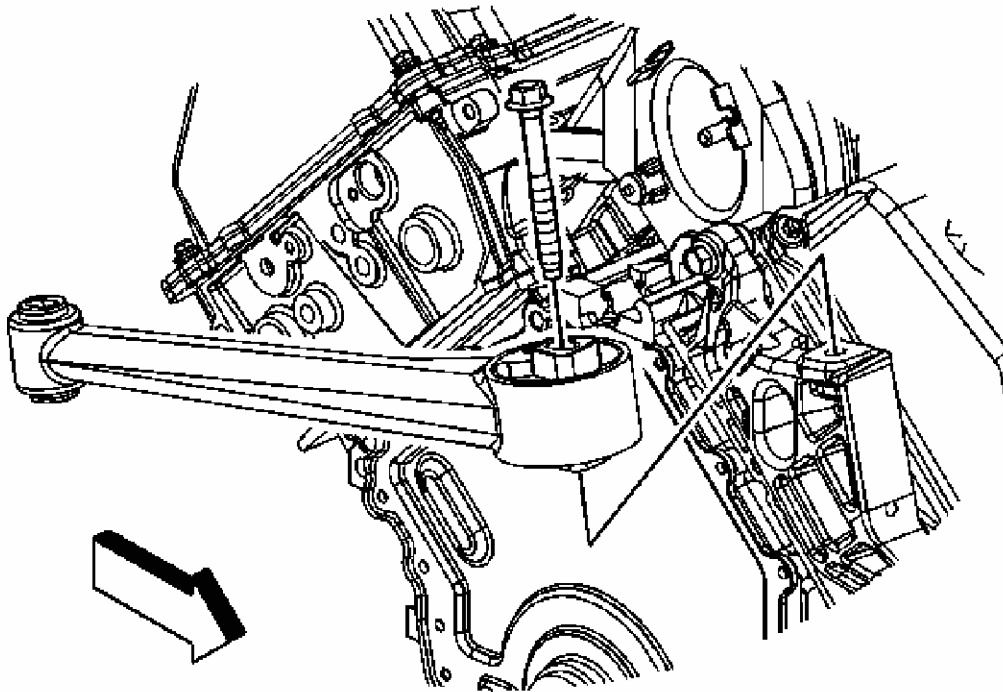


Fig. 20: View Of Engine Mount Strut
Courtesy of GENERAL MOTORS CORP.

4. Install the engine mount strut.

NOTE: Refer to Fastener Notice .

5. Install the engine mount strut bolt.

Tighten: Tighten the bolt to 70 N.m (52 lb ft).

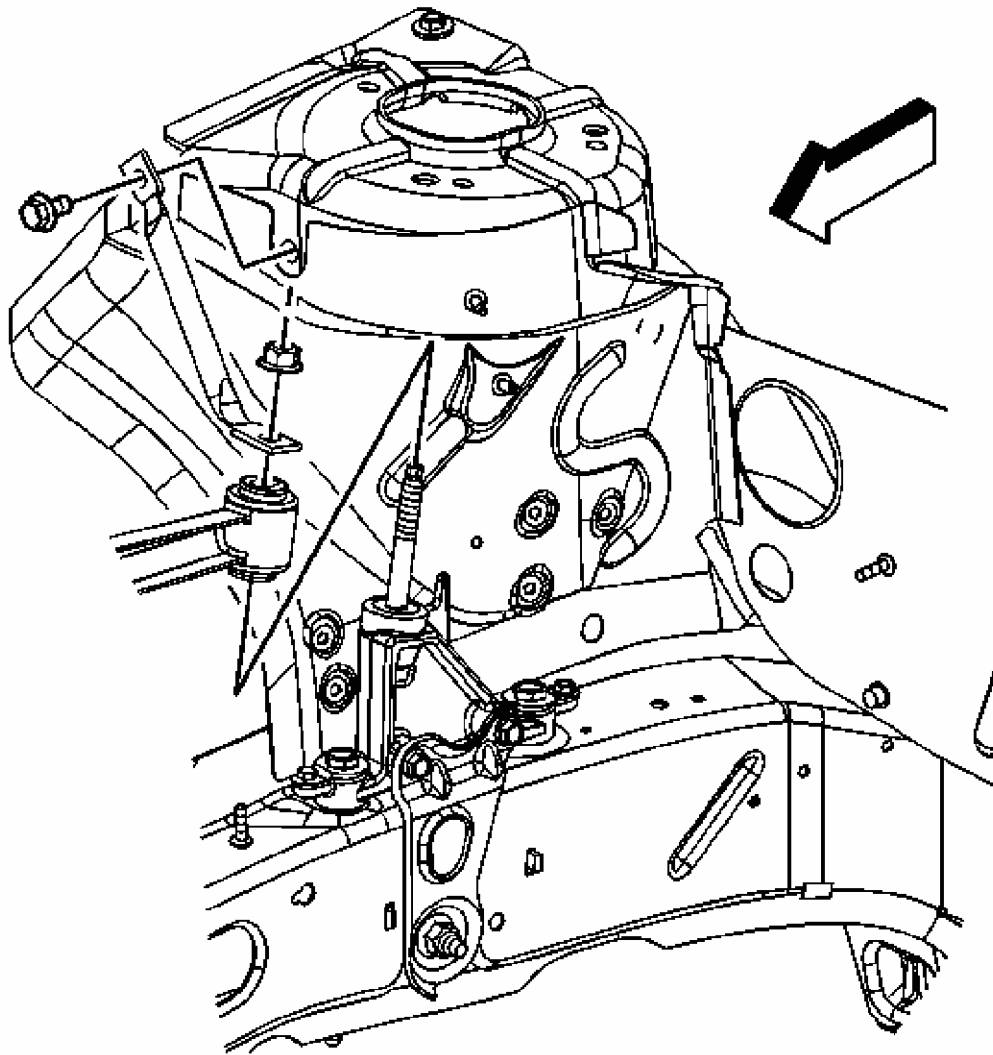


Fig. 21: View Of Engine Mount Strut Brace Bolt & Nut
Courtesy of GENERAL MOTORS CORP.

6. Install the engine mount strut brace.
7. Install the engine mount strut brace bolt and nut.

Tighten:

- Tighten the bolt to 50 N.m (37 lb ft).
- Tighten the nut to 70 N.m (52 lb ft).

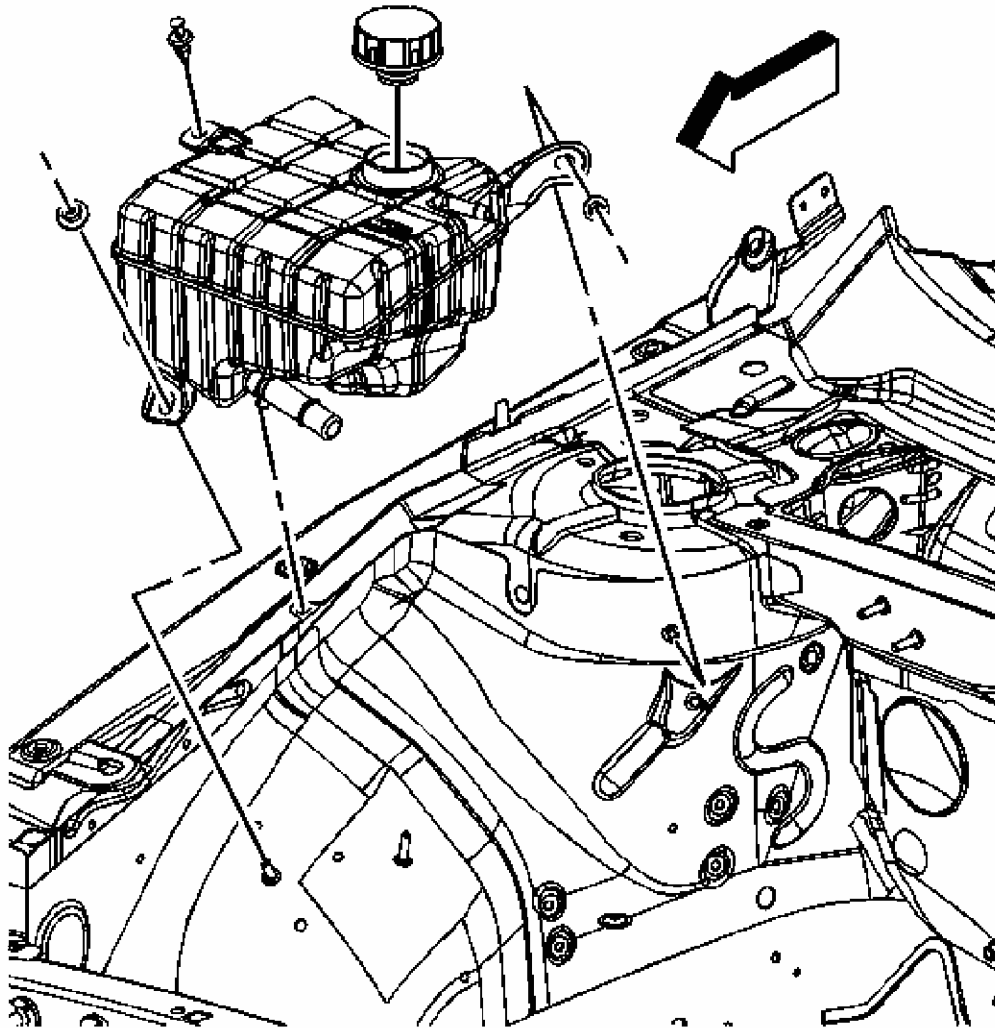


Fig. 22: Identifying Surge Tank
Courtesy of GENERAL MOTORS CORP.

8. Position the surge tank to the studs.
9. Install the surge tank nuts and push pin retainer.

Tighten: Tighten the nuts to 6 N.m (53 lb in).

10. Install the front compartment sight shield. Refer to **Front Compartment Sight Shields Replacement**.
11. Install the air inlet grille. Refer to **Air Inlet Grille Panel Replacement**.

ENGINE FRONT MOUNT REPLACEMENT

REMOVAL PROCEDURE

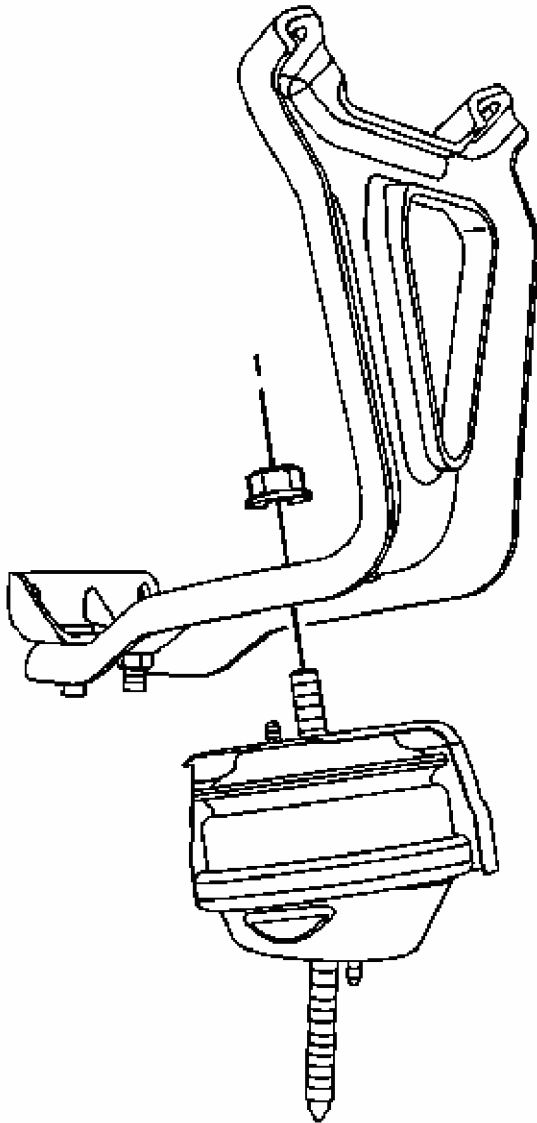


Fig. 23: Identifying Front Engine Mount
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine mount bracket. Refer to **Engine Front Mount Bracket Replacement**.

2. Remove the front engine mount to engine mount bracket nut.
3. Remove the front engine mount.

INSTALLATION PROCEDURE

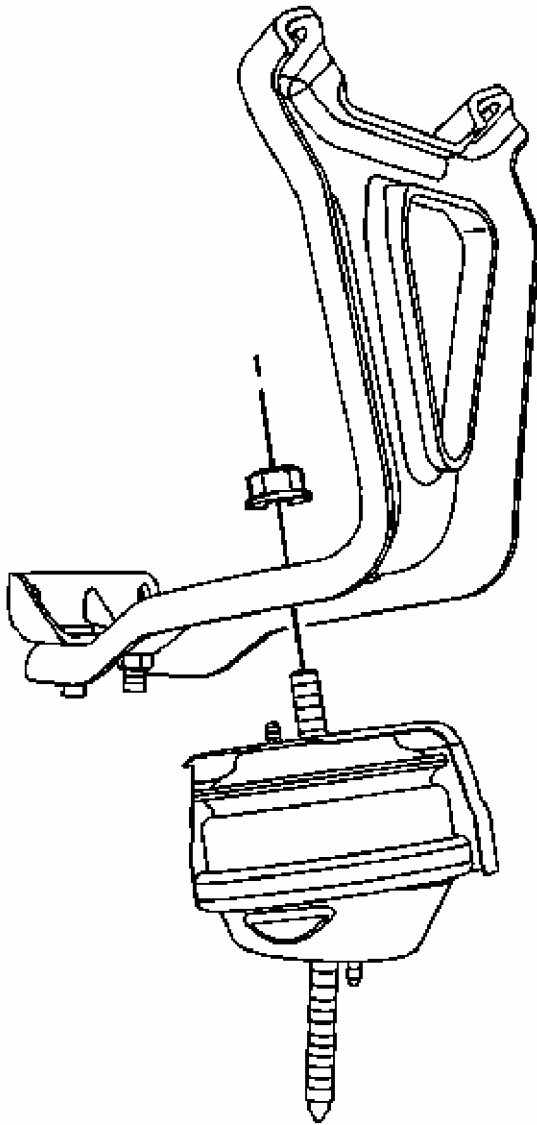


Fig. 24: Identifying Front Engine Mount
Courtesy of GENERAL MOTORS CORP.

1. Install the front engine mount stud through the hole in the front engine mount bracket.

2. Install the front engine mount bracket. Refer to **Engine Front Mount Bracket Replacement**.

NOTE: Refer to **Fastener Notice** .

3. Install the front engine mount to engine mount bracket nut.

Tighten: Tighten the nut to 80 N.m (59 lb ft).

4. Install the frame. Refer to **Front Frame Replacement (3.8L)** or **Front Frame Replacement (4.6L)** .

ENGINE MOUNT INSPECTION

IMPORTANT: Before replacing any engine mount due to suspected fluid loss, verify that the source of the fluid is the engine mount, not the engine or accessories.

1. Install the engine support fixture. Refer to **Engine Support Fixture**. Raising the engine removes the weight from the engine mount and creates slight tension in the rubber.
2. Observe the engine mount while raising the engine. Replace the engine mount if the engine mount exhibits any of the following conditions:
 - The hard rubber surface is covered with heat check cracks.
 - The rubber is separated from the metal plate of the engine mount.
 - The rubber is split through the center of the engine mount.
3. If there is movement between the metal plate of the engine mount and its attaching points, lower the engine on the engine mount. Tighten the bolts or nuts attaching the engine mount to the frame or engine mount bracket. Refer to **Engine Front Mount Replacement** or **Engine Mount Replacement - Right Side**.

ENGINE MOUNT REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

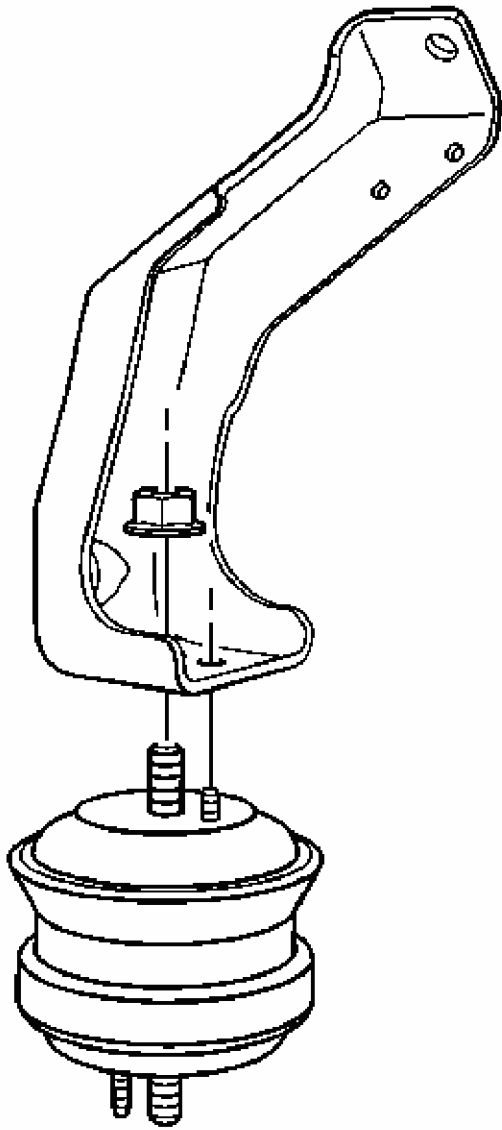


Fig. 25: Right Engine Mount
Courtesy of GENERAL MOTORS CORP.

1. Remove the frame. Refer to **Front Frame Replacement (3.8L)** or **Front Frame Replacement (4.6L)** .
2. Remove the right engine mount to engine mount bracket nut.
3. Remove the right engine mount.

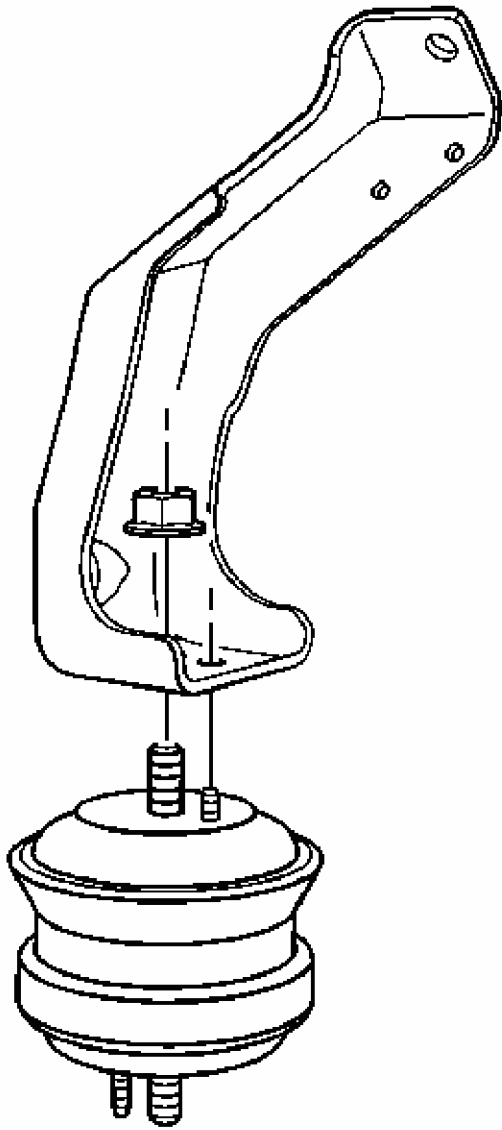


Fig. 26: Right Engine Mount
Courtesy of GENERAL MOTORS CORP.

1. Install the right engine mount stud through the hole in the engine mount bracket.

NOTE: **Refer to Fastener Notice .**

2. Install the right engine mount to engine mount bracket nut.

Tighten: Tighten the nut to 80 N.m (59 lb ft).

3. Install the frame. Refer to **Front Frame Replacement (3.8L)** or **Front Frame Replacement (4.6L)** .

ENGINE FRONT MOUNT BRACKET REPLACEMENT

REMOVAL PROCEDURE

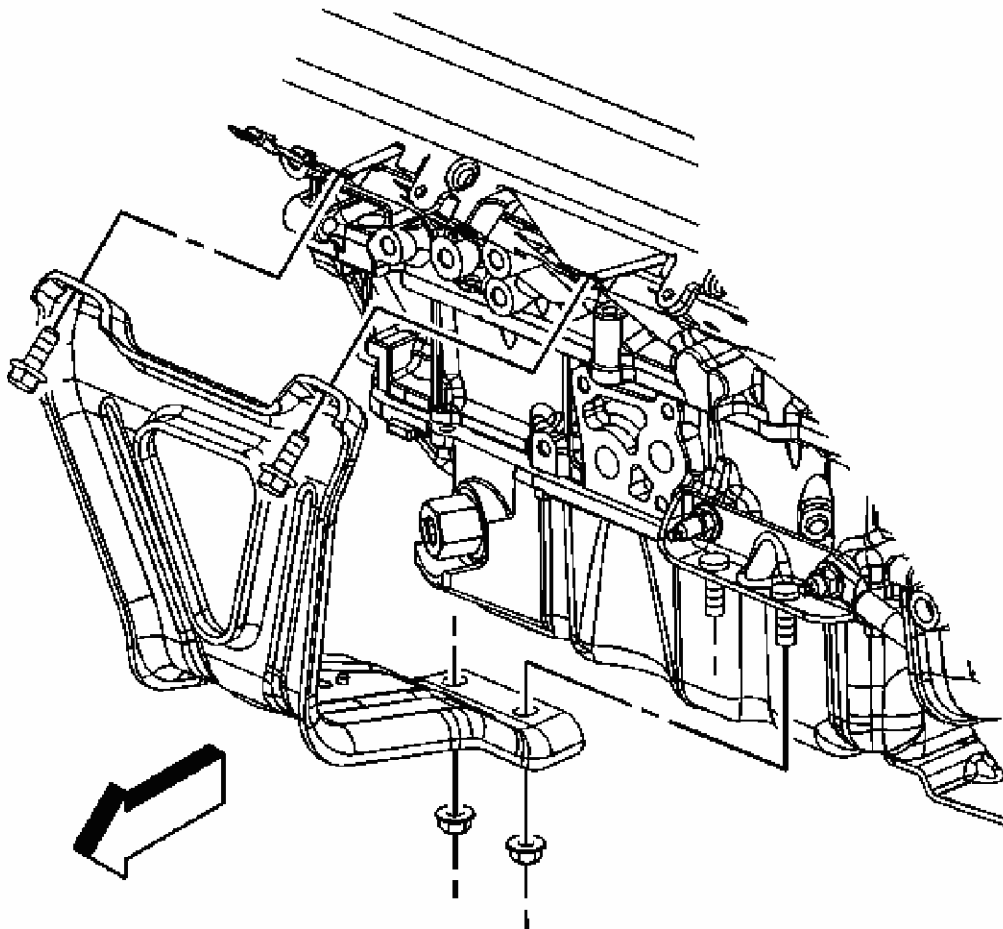


Fig. 27: Identifying Front Engine Mount Bracket Bolts/Nuts
Courtesy of GENERAL MOTORS CORP.

1. Remove the front frame. Refer to **Front Frame Replacement (3.8L)** or **Front Frame Replacement (4.6L)** .
2. Remove the engine mount bracket to cylinder head bolts.

3. Remove the upper engine mount bracket to lower engine mount bracket nuts.
4. Remove the upper engine mount bracket.

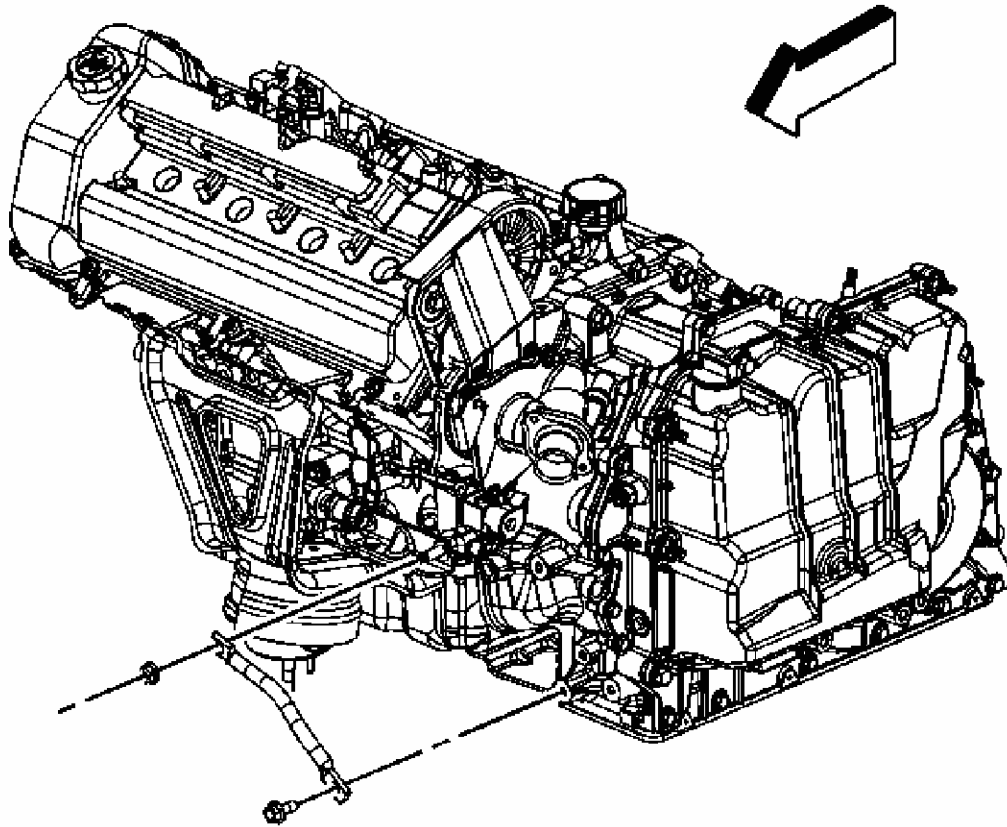


Fig. 28: View Of Transaxle Brace & Bolt
Courtesy of GENERAL MOTORS CORP.

5. Remove the transaxle brace bolt.

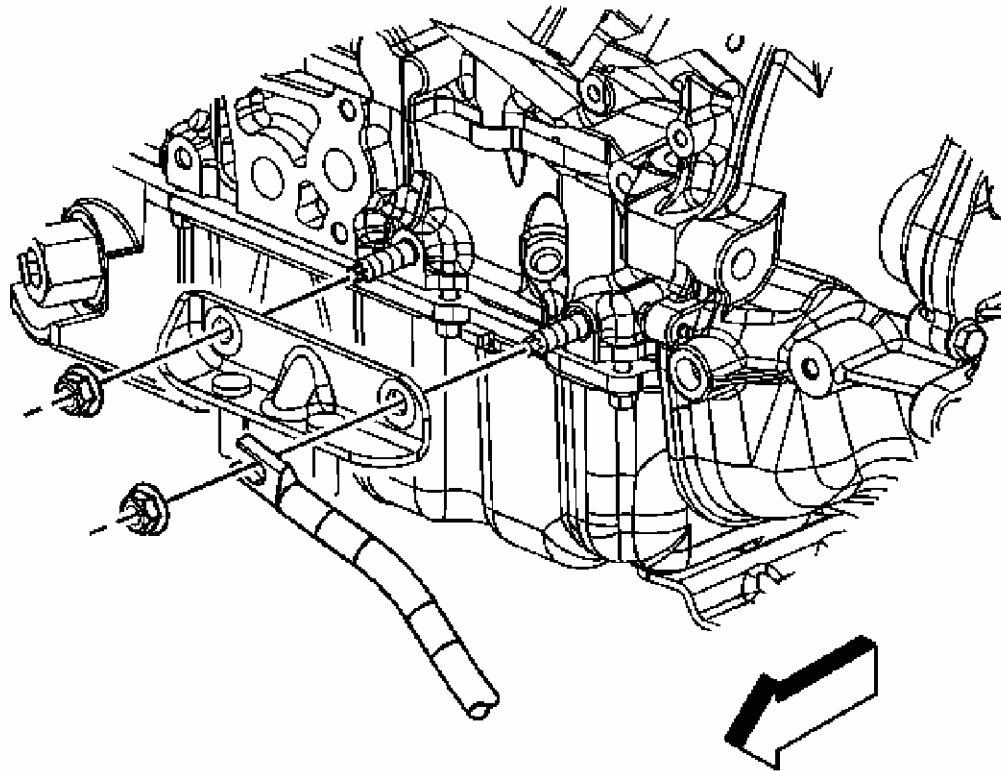


Fig. 29: View Of Lower Engine Mount Bracket-To-Engine Stud Nuts
Courtesy of GENERAL MOTORS CORP.

6. Remove the lower engine mount bracket to engine stud nuts.
7. Remove the transaxle brace.
8. Remove the lower engine mount bracket.

INSTALLATION PROCEDURE

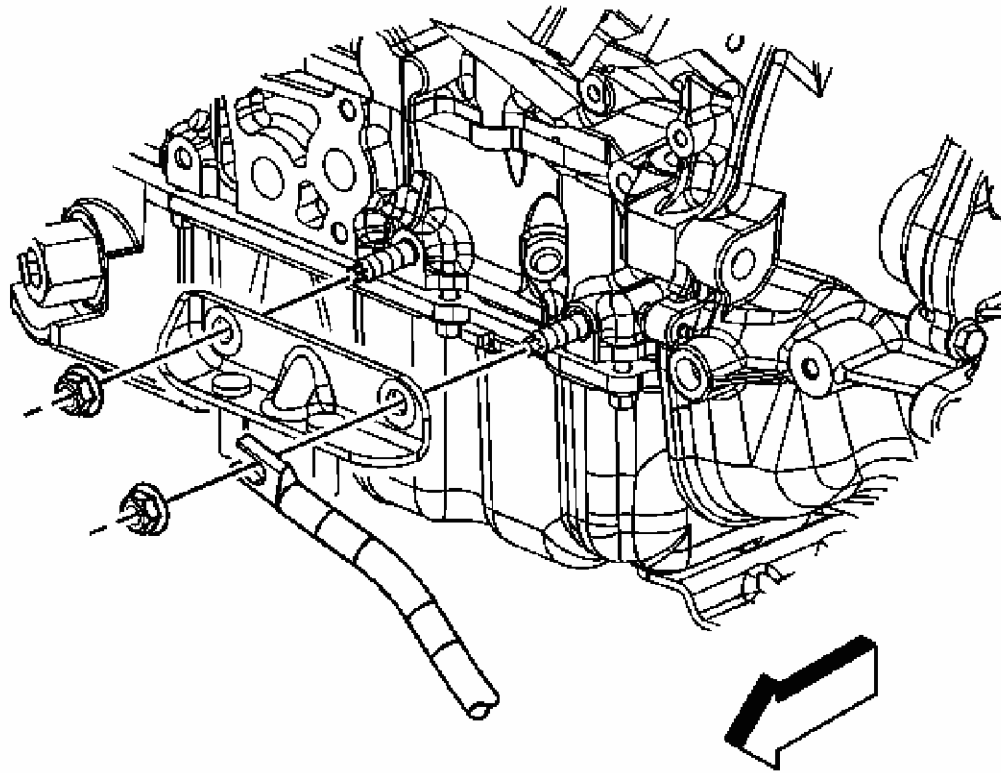


Fig. 30: View Of Lower Engine Mount Bracket-To-Engine Stud Nuts
Courtesy of GENERAL MOTORS CORP.

1. Install the lower engine mount bracket onto the engine studs.
2. Install the transaxle brace.
3. Install the lower engine mount bracket to engine stud nuts finger tight.

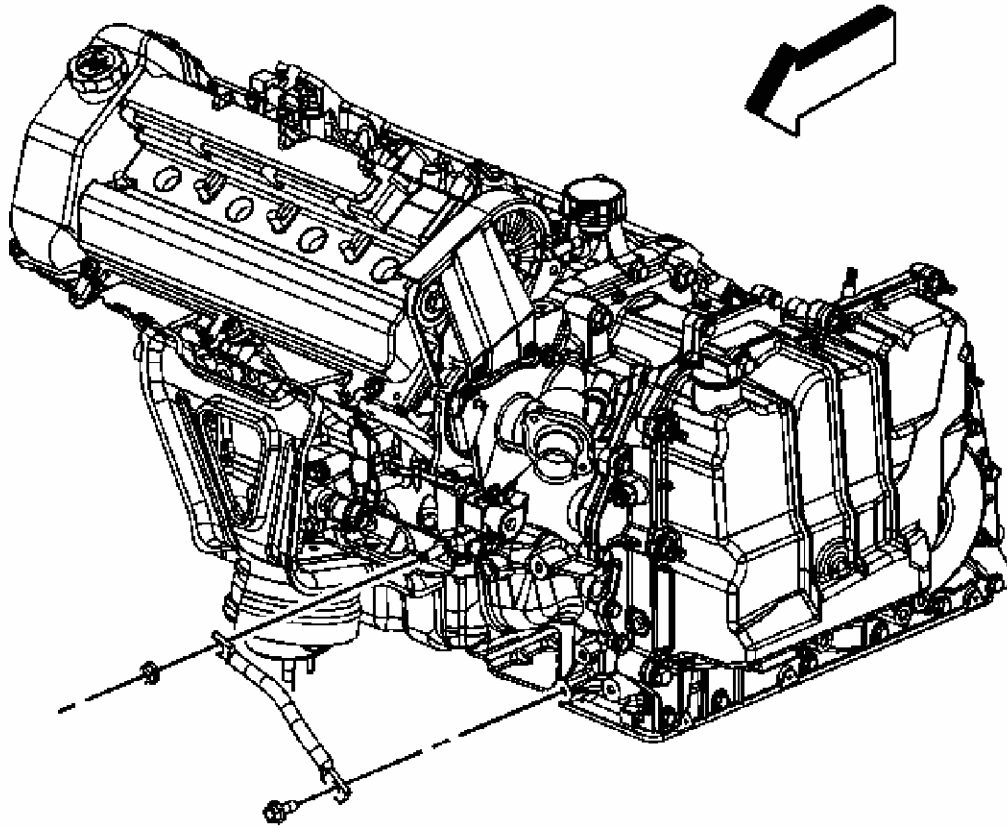


Fig. 31: View Of Transaxle Brace & Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

4. Install the transaxle brace bolt.

Tighten:

- Tighten the transaxle brace bolt to 50 N.m (37 lb ft).
- Tighten the lower engine mount bracket to engine stud nuts to 50 N.m (37 lb ft).

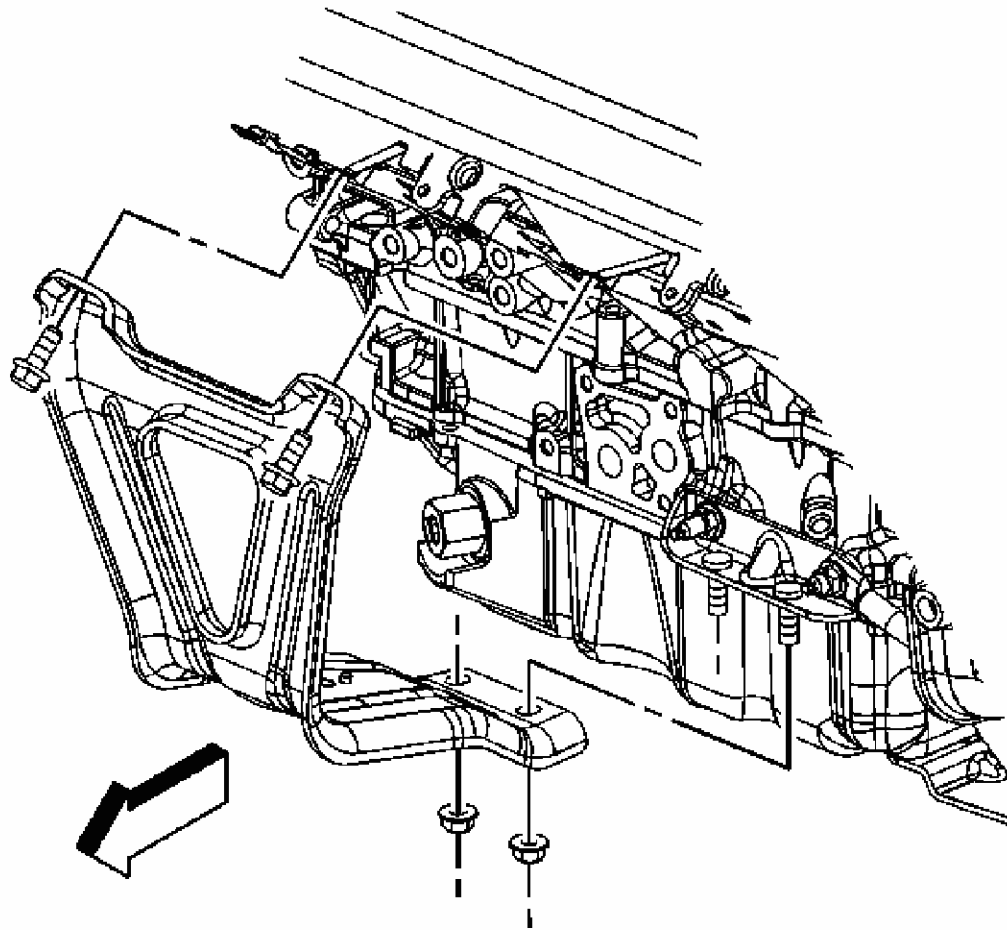


Fig. 32: Identifying Front Engine Mount Bracket Bolts/Nuts
Courtesy of GENERAL MOTORS CORP.

5. Install the upper engine mount bracket onto the studs.
6. Install the engine mount bracket to cylinder head bolts.

Tighten: Tighten the bolts to 50 N.m (37 lb ft).

7. Install the upper engine mount bracket to lower engine mount bracket nuts.

Tighten: Tighten the nuts to 50 N.m (37 lb ft).

8. Install the front frame. Refer to **Front Frame Replacement (3.8L)** or **Front Frame Replacement (4.6L)** .

ENGINE MOUNT BRACKET REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

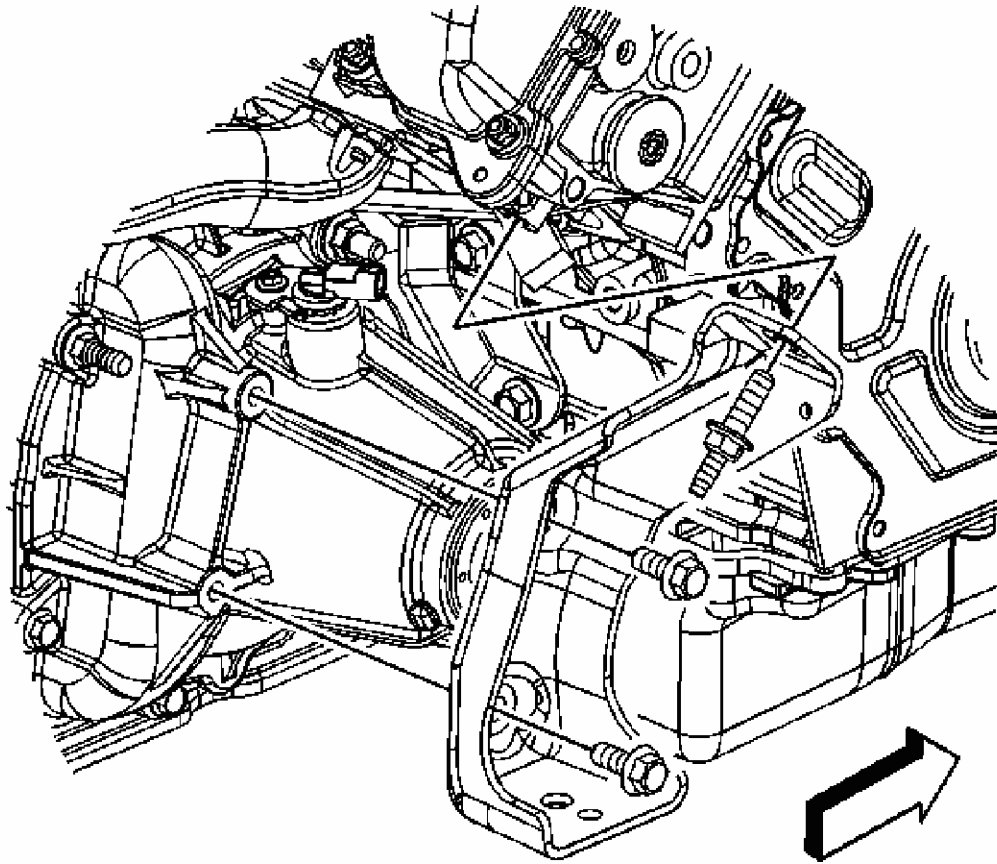


Fig. 33: Identifying Right Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

1. Remove the right engine mount. Refer to **Engine Mount Replacement - Right Side**.
2. Remove the right engine mount bracket to engine stud.
3. Remove the right engine mount bracket to transaxle bolts.
4. Remove the right engine mount bracket.

INSTALLATION PROCEDURE

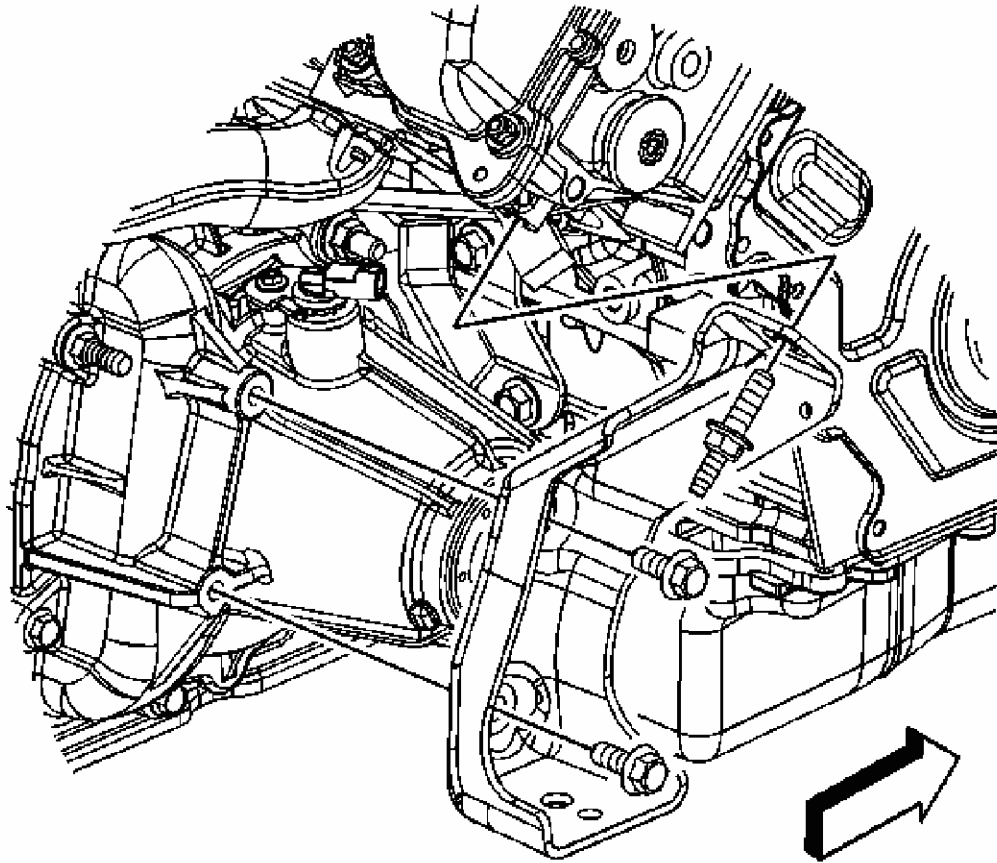


Fig. 34: Identifying Right Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

1. Position the right engine mount bracket to the correct holes in the engine block and transaxle.
2. Install the right engine mount bracket to transaxle bolts finger tight.

NOTE: Refer to Fastener Notice .

3. Install the right engine mount bracket to engine stud.

Tighten: Tighten the bolts/stud to 73 N.m (54 lb ft).

4. Install the right engine mount. Refer to Engine Mount Replacement - Right Side.

ENGINE MOUNT STRUT REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

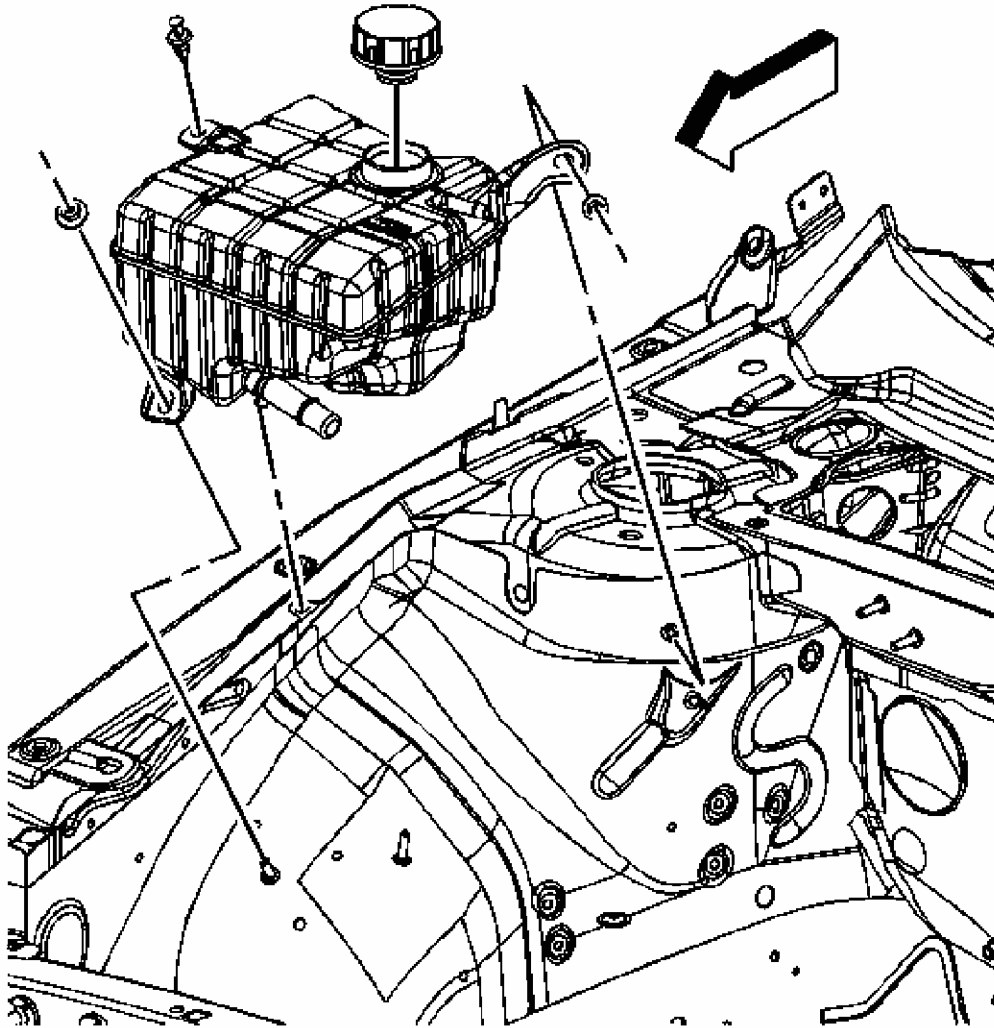


Fig. 35: Identifying Surge Tank
Courtesy of GENERAL MOTORS CORP.

1. Remove the surge tank nuts and push pin retainer.
2. Remove the surge tank from the studs and position the tank aside.

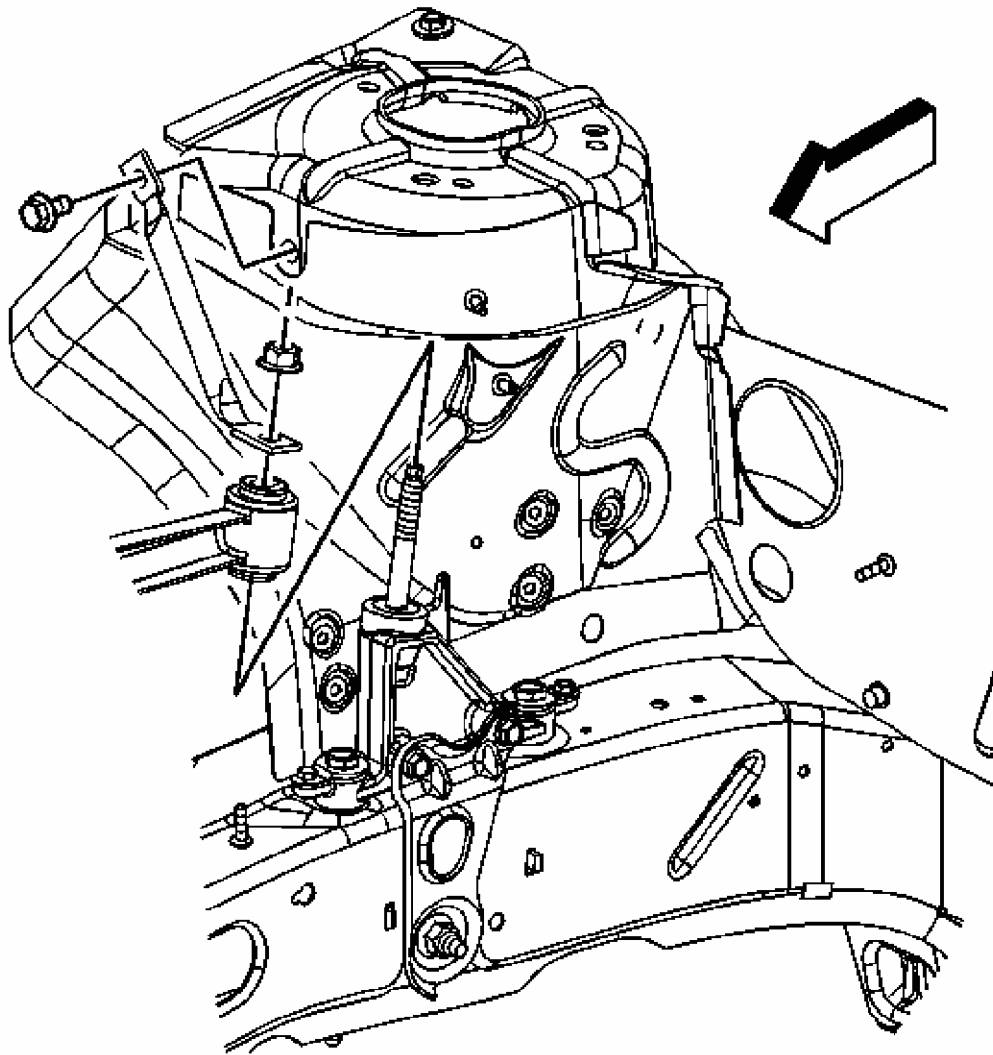


Fig. 36: View Of Engine Mount Strut Brace Bolt & Nut
Courtesy of GENERAL MOTORS CORP.

3. Remove the engine mount strut brace bolt and nut.
4. Remove the engine mount strut brace.

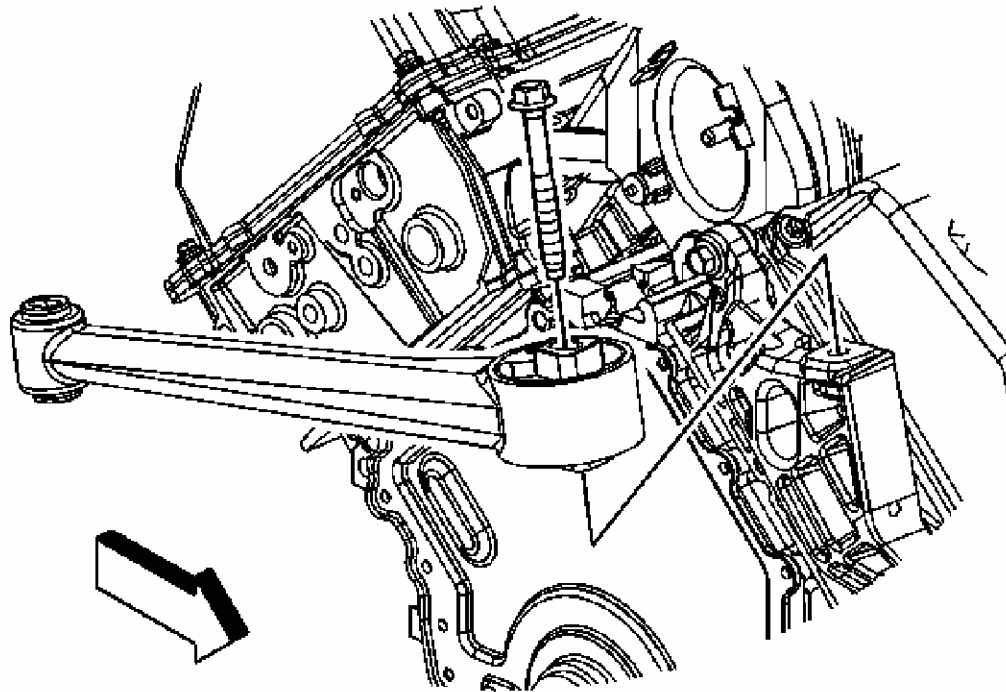


Fig. 37: Identifying Engine Mount Strut Bolt
Courtesy of GENERAL MOTORS CORP.

5. Remove the engine mount strut bolt.
6. Remove the engine mount strut.

INSTALLATION PROCEDURE

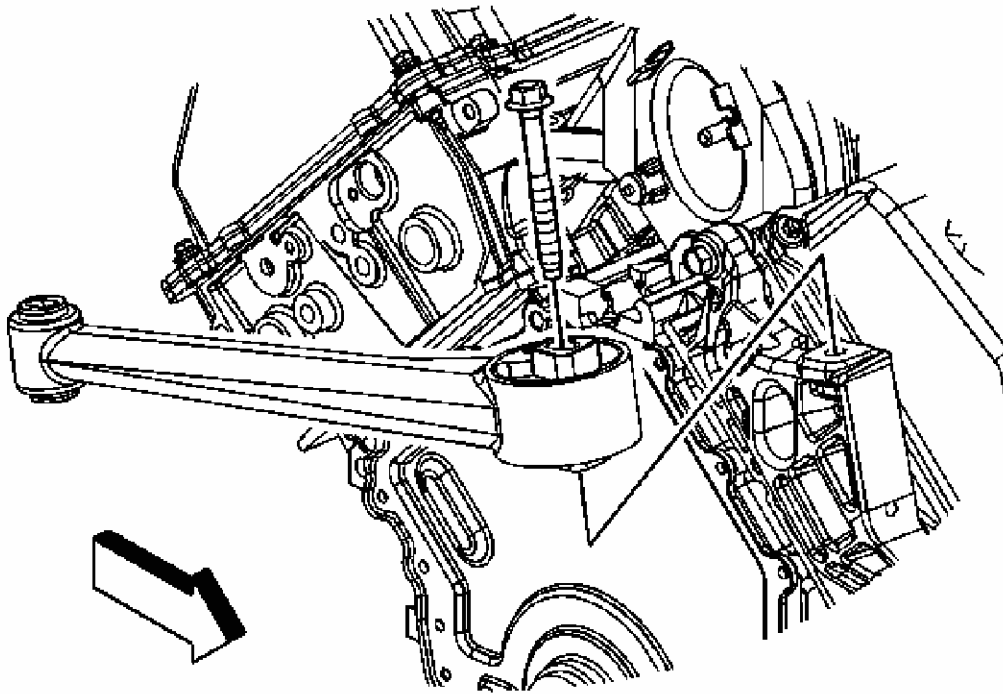


Fig. 38: Identifying Engine Mount Strut Bolt
Courtesy of GENERAL MOTORS CORP.

1. Install the engine mount strut.

NOTE: Refer to Fastener Notice .

2. Install the engine mount strut bolt.

Tighten: Tighten the bolt to 70 N.m (52 lb ft).

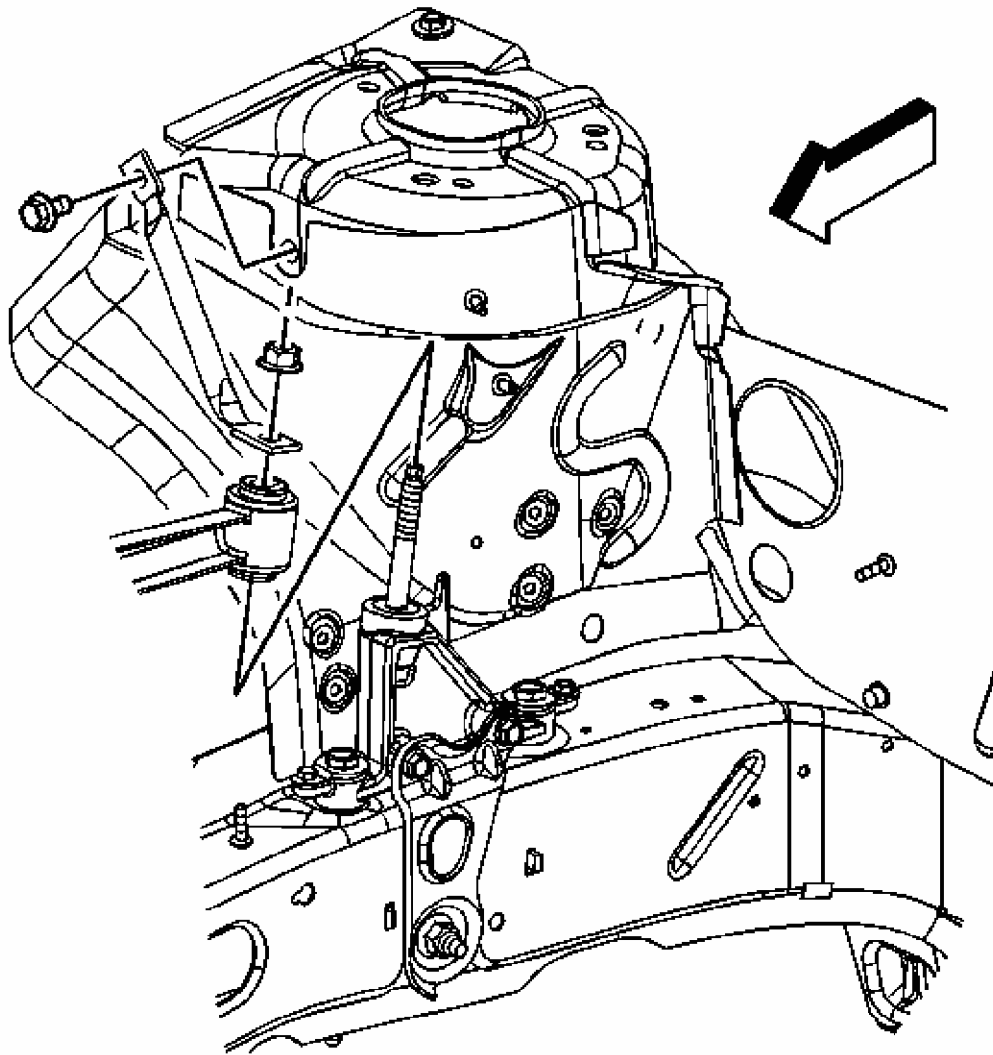


Fig. 39: View Of Engine Mount Strut Brace Bolt & Nut
Courtesy of GENERAL MOTORS CORP.

3. Install the engine mount strut brace.
4. Install the engine mount strut brace bolt and nut.

Tighten:

- Tighten the bolt to 50 N.m (37 lb ft).
- Tighten the nut to 70 N.m (52 lb ft).

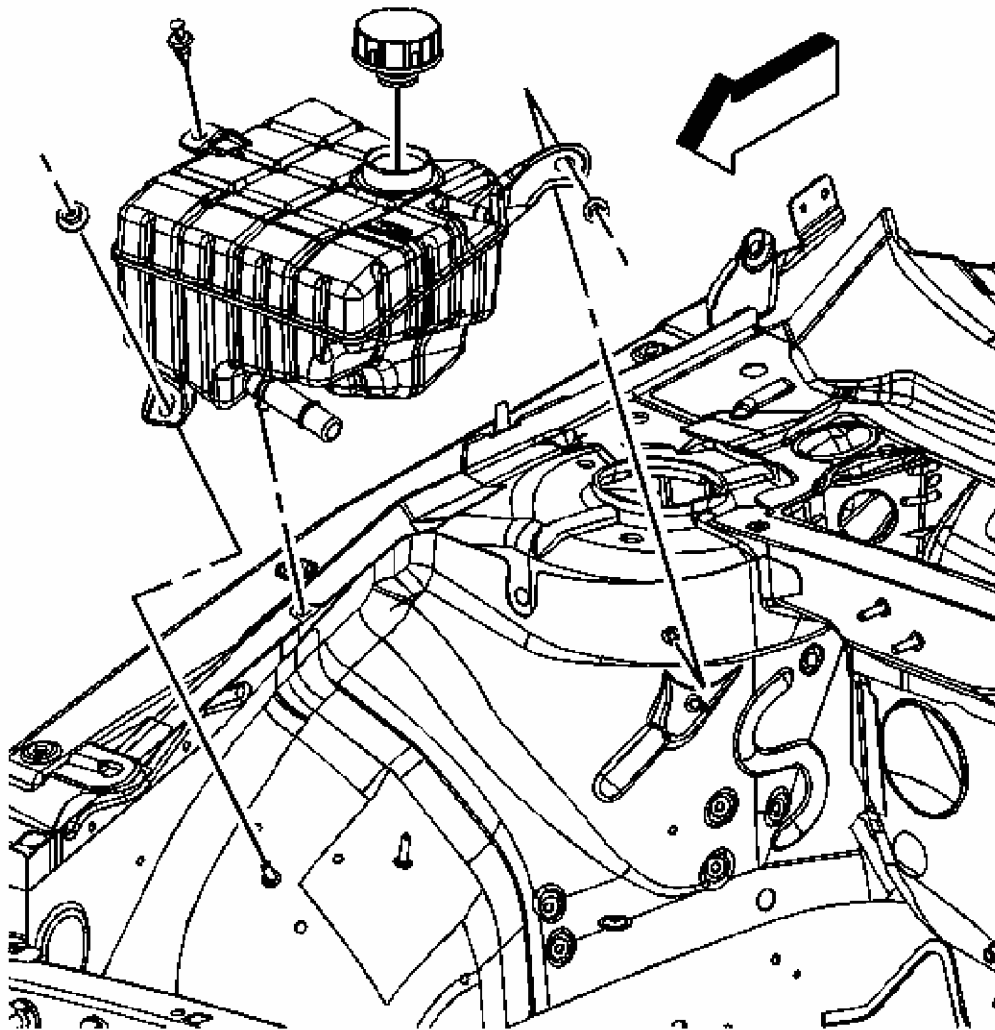


Fig. 40: Identifying Surge Tank
Courtesy of GENERAL MOTORS CORP.

5. Position the surge tank to the studs.
6. Install the surge tank nuts and push pin retainer.

Tighten: Tighten the nuts to 6 N.m (53 lb in).

ENGINE MOUNT STRUT BRACKET REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

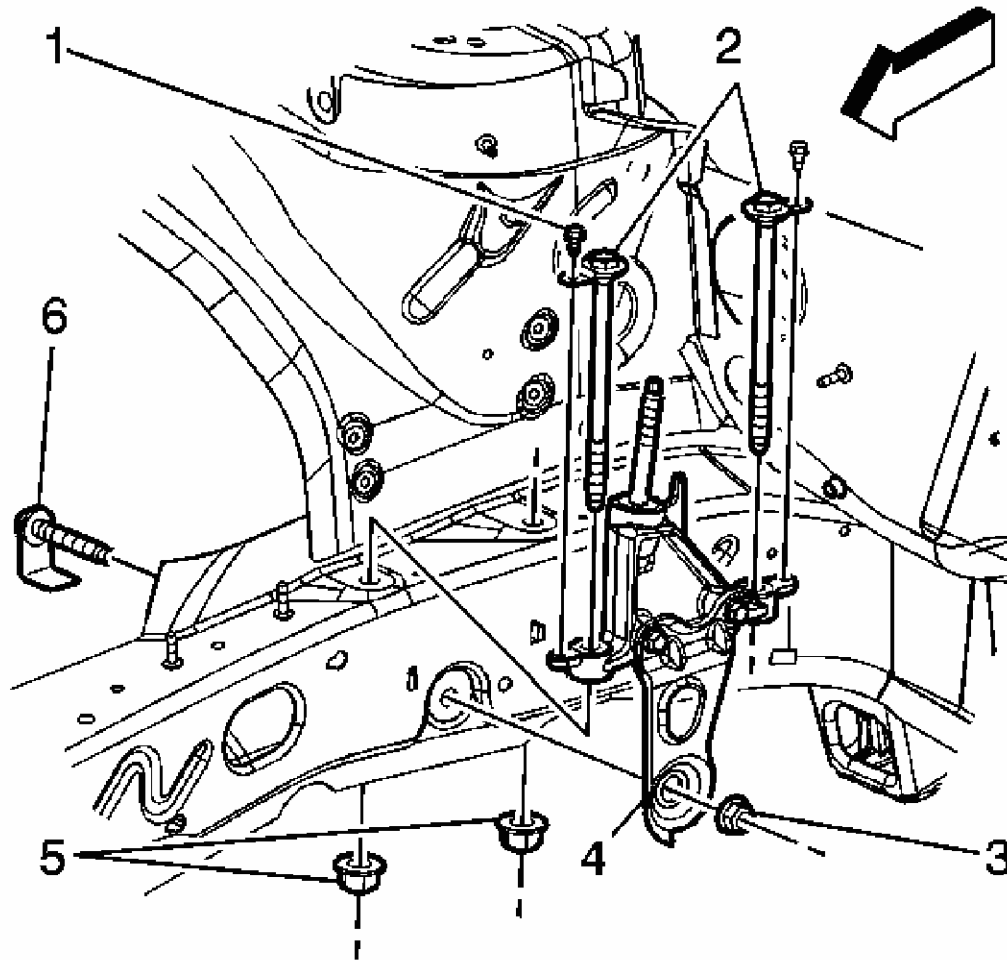


Fig. 41: View Of Engine Mount Strut Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine mount strut. Refer to **Engine Mount Strut Replacement - Right Side**.
2. Remove the right front wheel and tire. Refer to **Tire and Wheel Removal and Installation**.
3. Remove the engine mount strut bracket bolts (1).
4. Remove the strut bracket nut (3).
5. Remove the strut bracket bolt (6).
6. Remove the strut bracket nuts (5).
7. Remove the strut bracket bolts (2).
8. Remove the strut bracket (4).

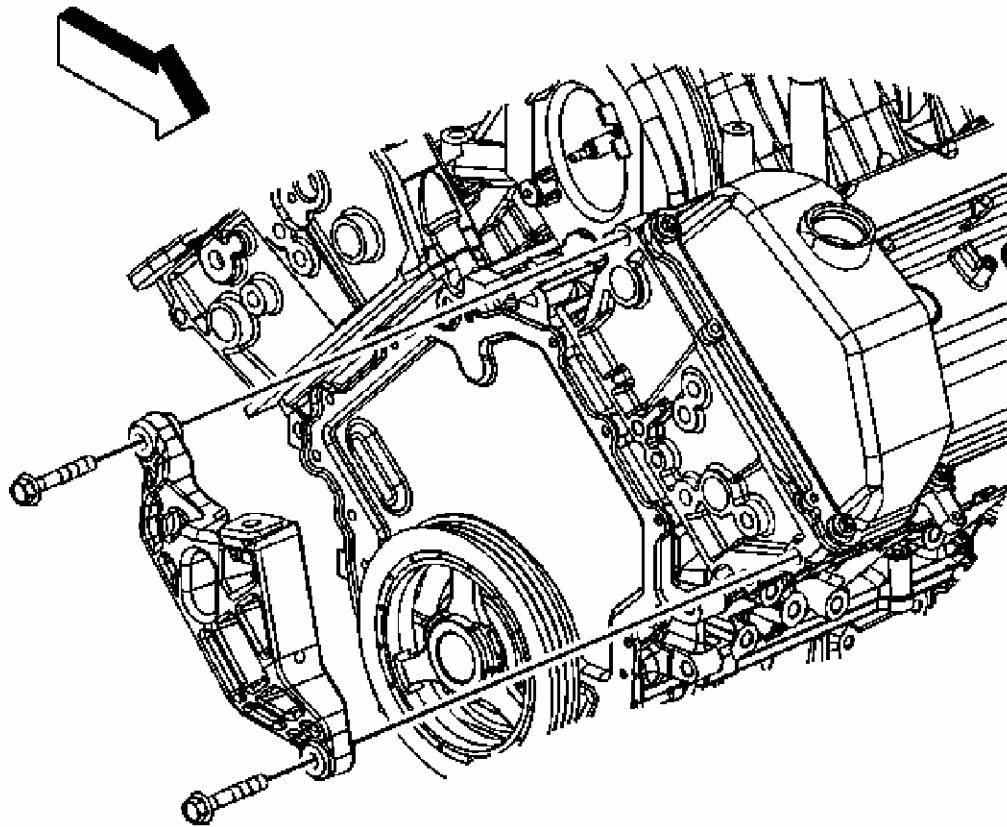


Fig. 42: View Of Engine Mount Strut Bracket-To-Engine Bolts
Courtesy of GENERAL MOTORS CORP.

9. Remove the engine mount strut bracket to engine bolts.
10. Remove the engine mount strut bracket.

INSTALLATION PROCEDURE

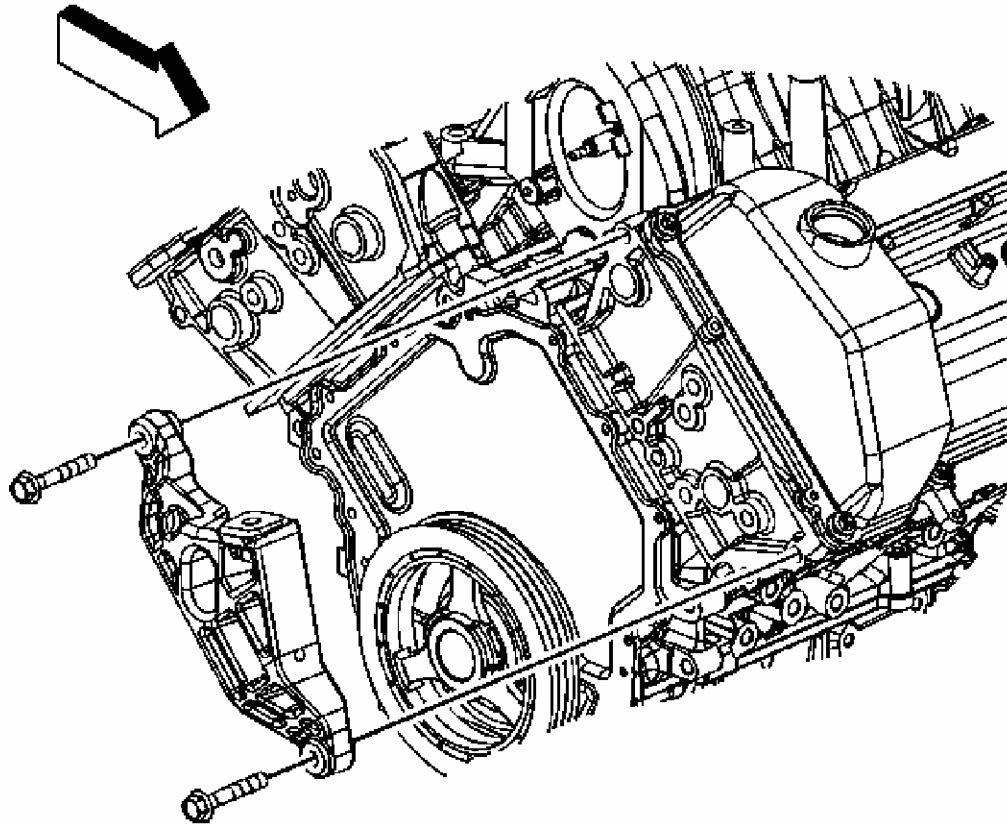


Fig. 43: View Of Engine Mount Strut Bracket-To-Engine Bolts
Courtesy of GENERAL MOTORS CORP.

1. Position the engine mount strut bracket to the cylinder head.

NOTE: Refer to Fastener Notice .

2. Install the engine mount strut bracket to engine bolts.

Tighten: Tighten the bolts to 50 N.m (37 lb ft).

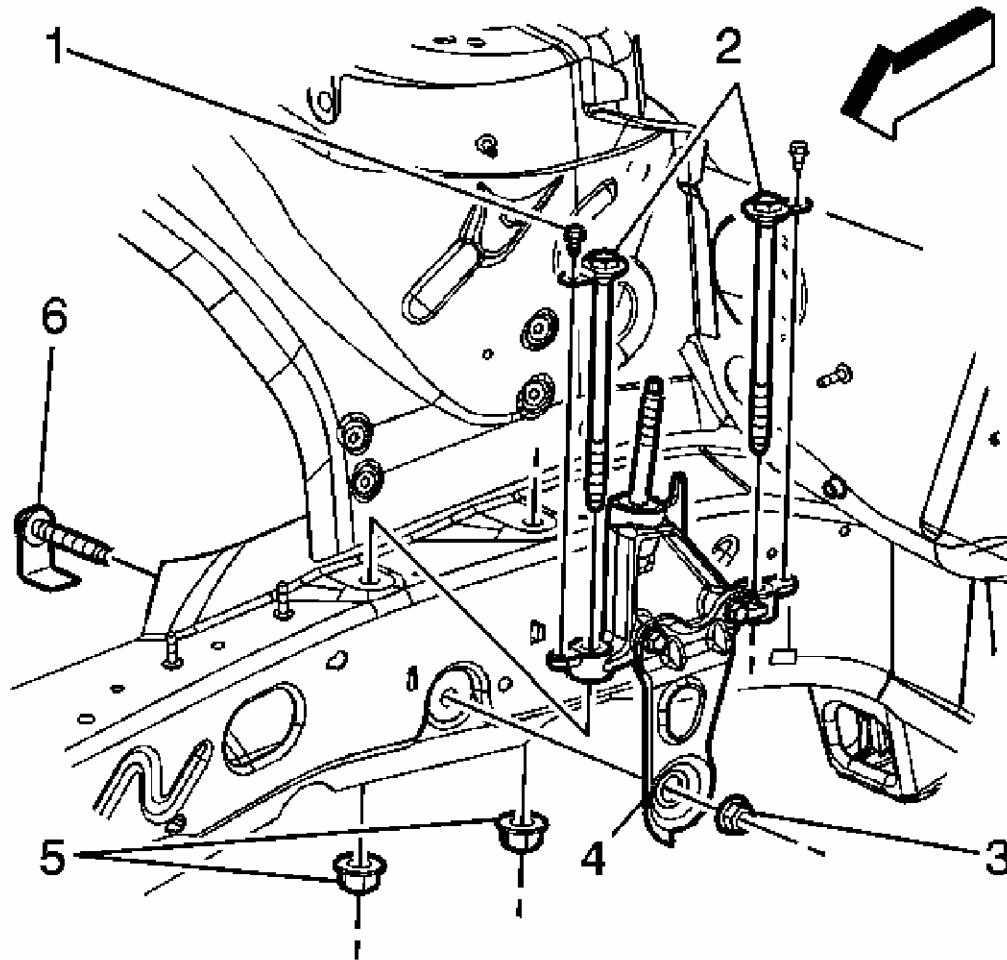


Fig. 44: View Of Engine Mount Strut Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

3. Position the engine mount strut bracket (4) to the front compartment rail.
4. Install the strut bracket bolts (2).
5. Install the strut bracket bolt (6).
6. Install the strut bracket nut (3).

Tighten: Tighten the nut to 70 N.m (52 lb ft).

7. Install the strut bracket nuts (5).

Tighten: Tighten the nuts to 70 N.m (52 lb ft).

8. Install the strut bracket bolts (1).

Tighten: Tighten the bolts to 6 N.m (53 lb in).

9. Install the right front wheel and tire. Refer to **Tire and Wheel Removal and Installation** .
10. Install the engine mount strut. Refer to **Engine Mount Strut Replacement - Right Side**.

ENGINE LIFT BRACKET REPLACEMENT

REMOVAL PROCEDURE

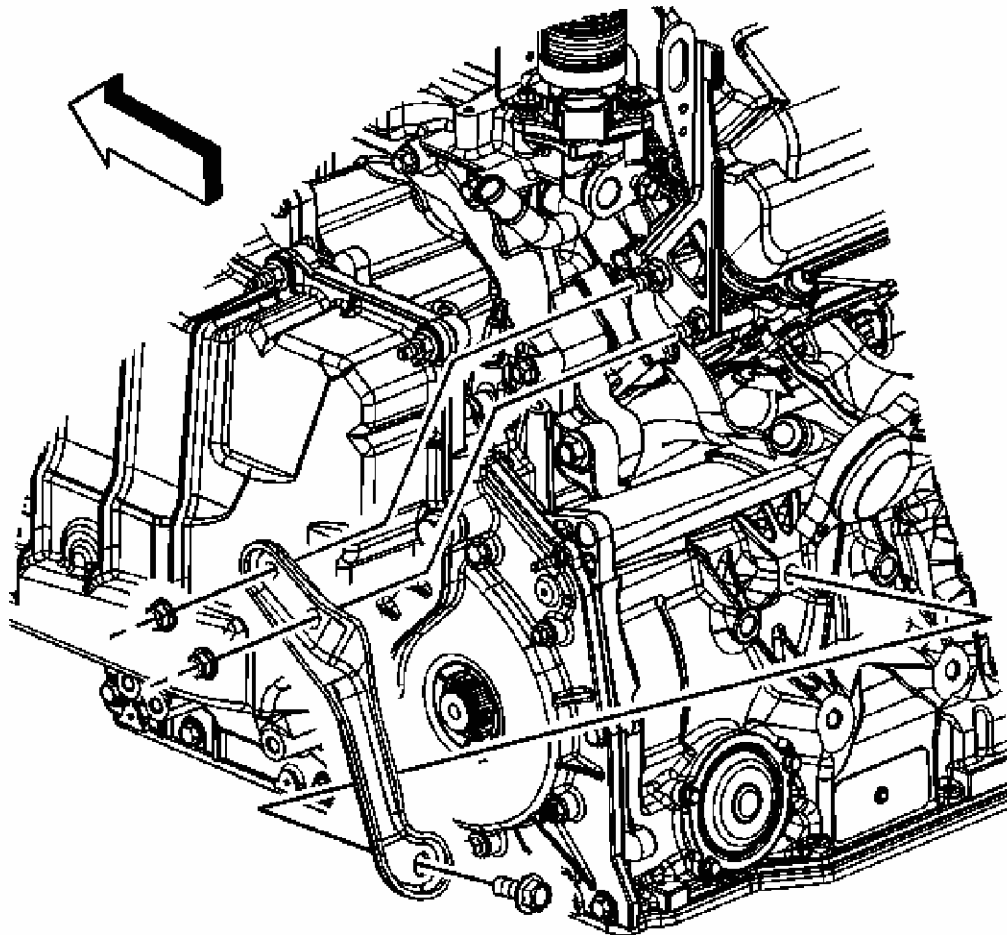


Fig. 45: Identifying Engine Lift Bracket
Courtesy of GENERAL MOTORS CORP.

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the transaxle brace lower bolt.
3. Lower the vehicle.
4. Remove the transaxle brace nuts.

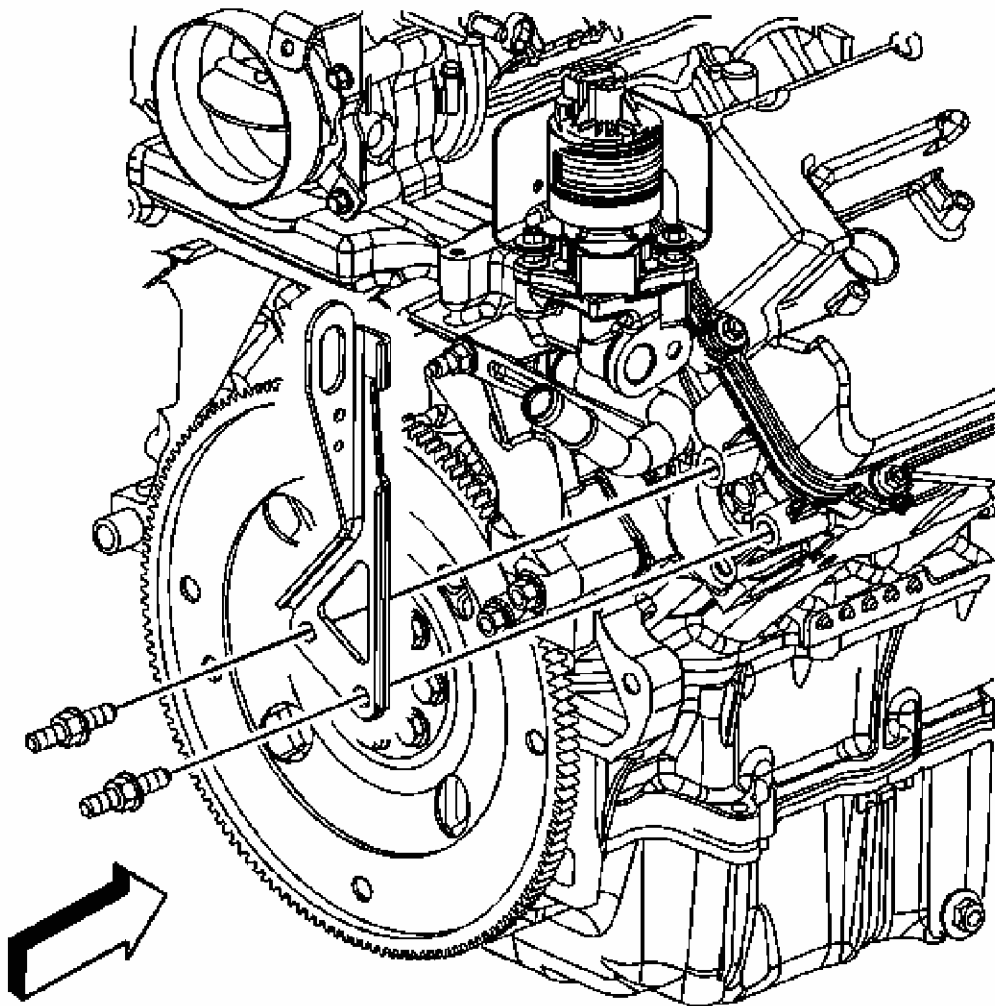


Fig. 46: Identifying Engine Lift Bracket Studs
Courtesy of GENERAL MOTORS CORP.

5. Remove the engine lift bracket studs.
6. Remove the engine lift bracket.

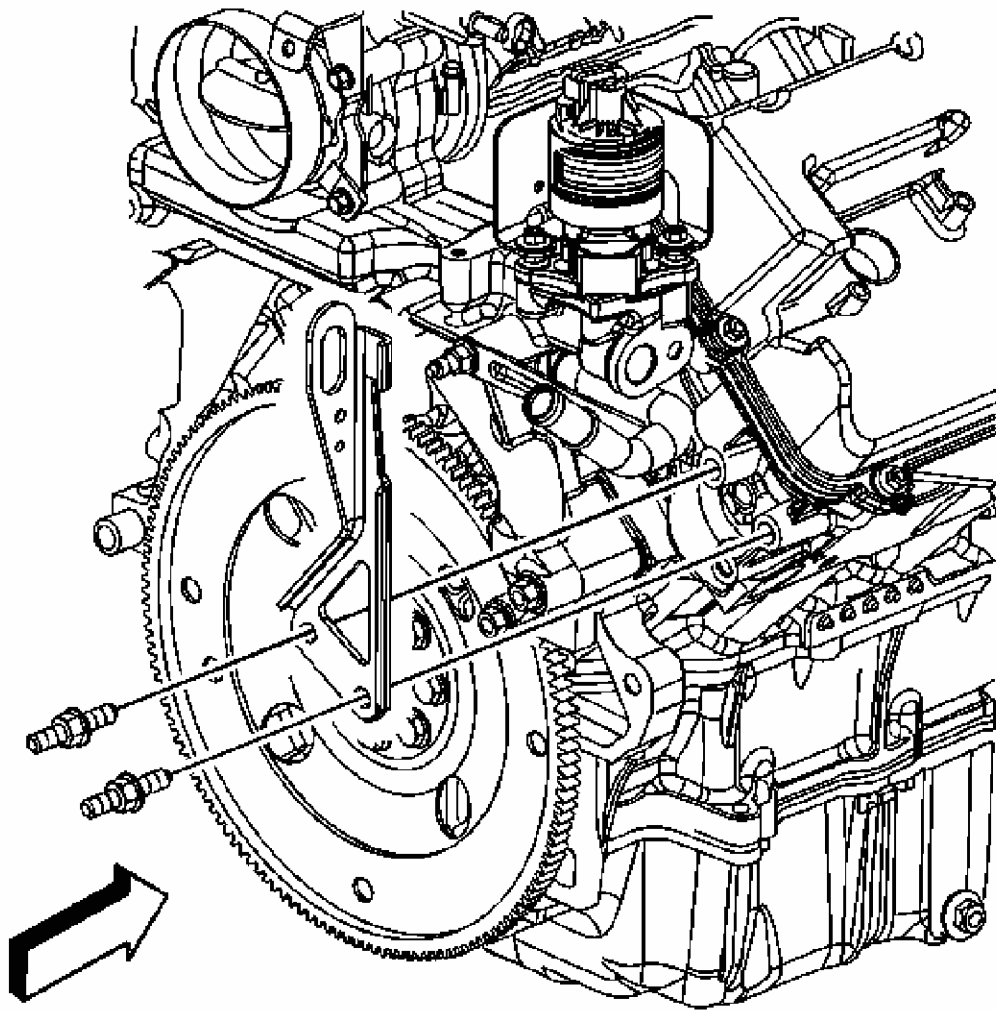


Fig. 47: Identifying Engine Lift Bracket Studs
Courtesy of GENERAL MOTORS CORP.

1. Position the engine lift bracket to the cylinder head.

NOTE: Refer to Fastener Notice .

2. Install the engine lift bracket studs.

Tighten: Tighten the studs to 50 N.m (37 lb ft).

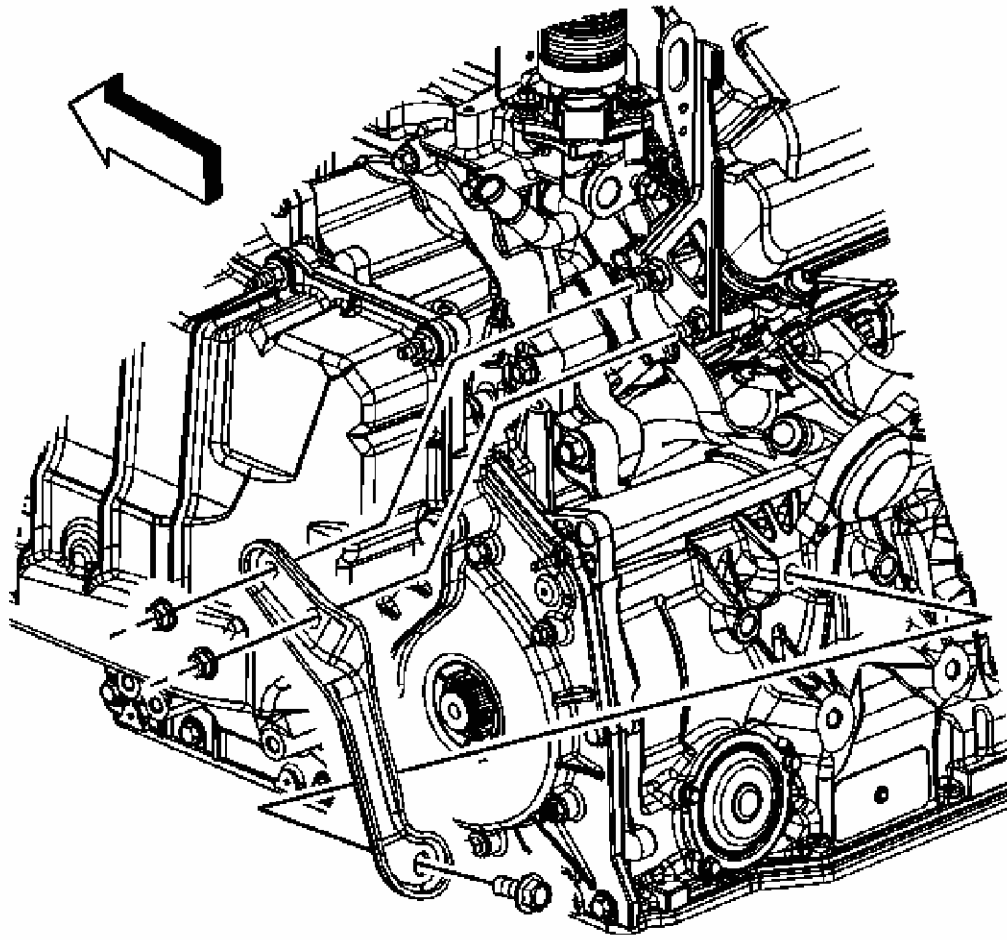


Fig. 48: Identifying Engine Lift Bracket
Courtesy of GENERAL MOTORS CORP.

3. Install the transaxle brace onto the lift bracket studs.
4. Install the transaxle brace nuts until snug.
5. Raise the vehicle.
6. Install the transaxle brace bolt.

Tighten: Tighten the bolt to 50 N.m (37 lb ft).

7. Lower the vehicle.
8. Tighten the transaxle brace nuts.

Tighten: Tighten the nuts to 50 N.m (37 lb ft).

FUEL INJECTOR SIGHT SHIELD REPLACEMENT

REMOVAL PROCEDURE

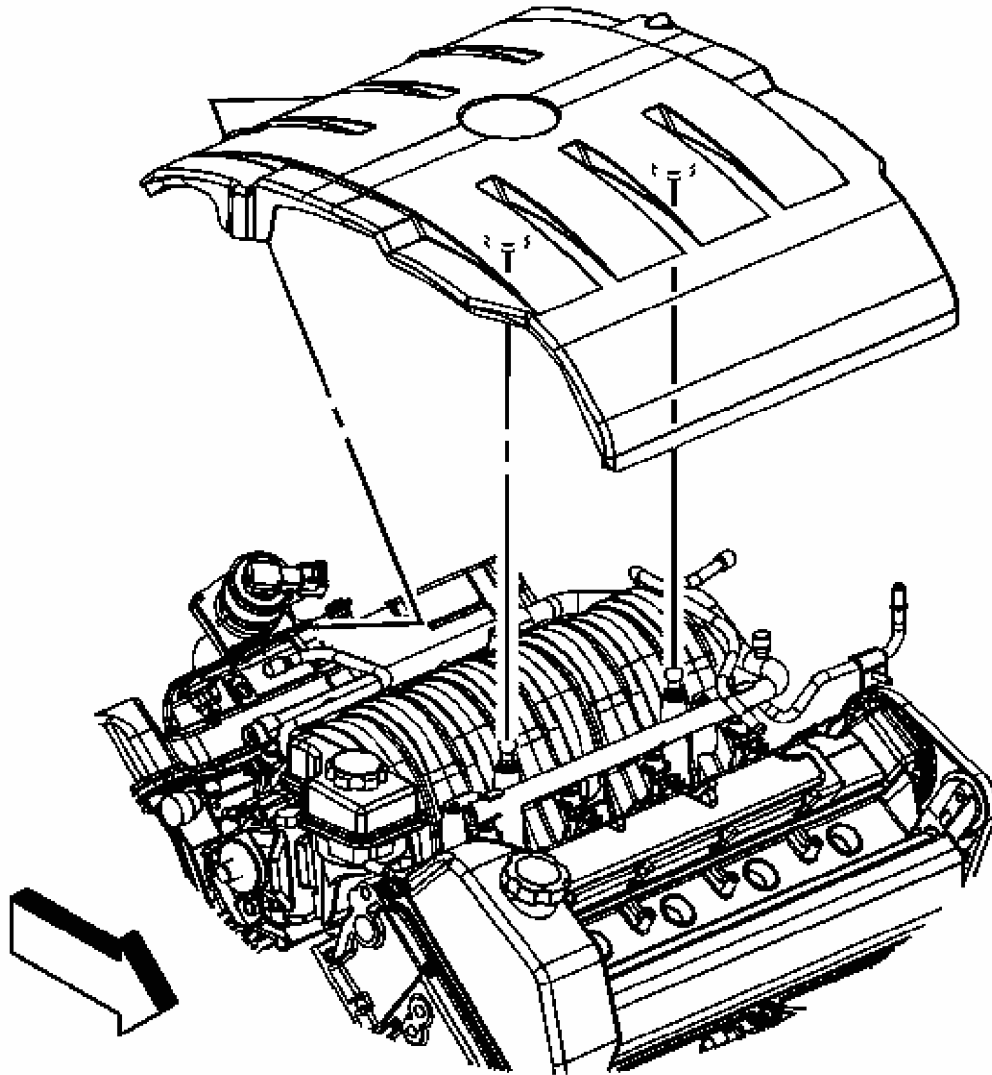


Fig. 49: Identifying Fuel Injector Sight Shield
Courtesy of GENERAL MOTORS CORP.

1. Grasp the intake manifold sight shield cover at the left side, lift up in order to disengage the cover from the ball stud.
2. Grasp the intake manifold sight shield cover at the right side, lift up in order to disengage the cover from the ball stud.

3. Remove the intake manifold sight shield cover from under the tab on the secondary air injection (AIR) check valve bracket.
4. Remove the intake manifold sight shield cover.

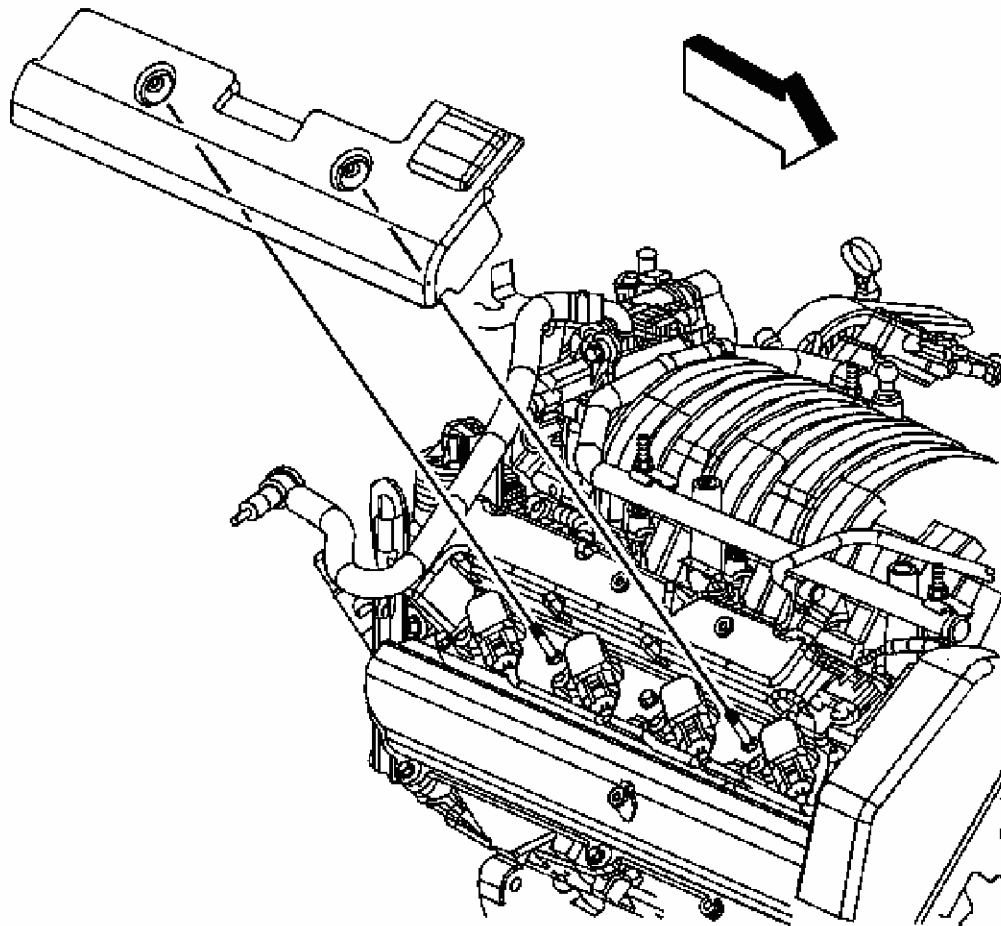


Fig. 50: Identifying Rear Intake Manifold Sight Shield
Courtesy of GENERAL MOTORS CORP.

5. If necessary to remove the rear intake manifold sight shield perform the following steps, remove the AIR check valve. Refer to **Secondary Air Injection Check Valve Replacement** .
6. Grasp the rear intake manifold sight shield cover and lift up in order to disengage the cover from the ball studs.
7. Remove the rear intake manifold sight shield cover.

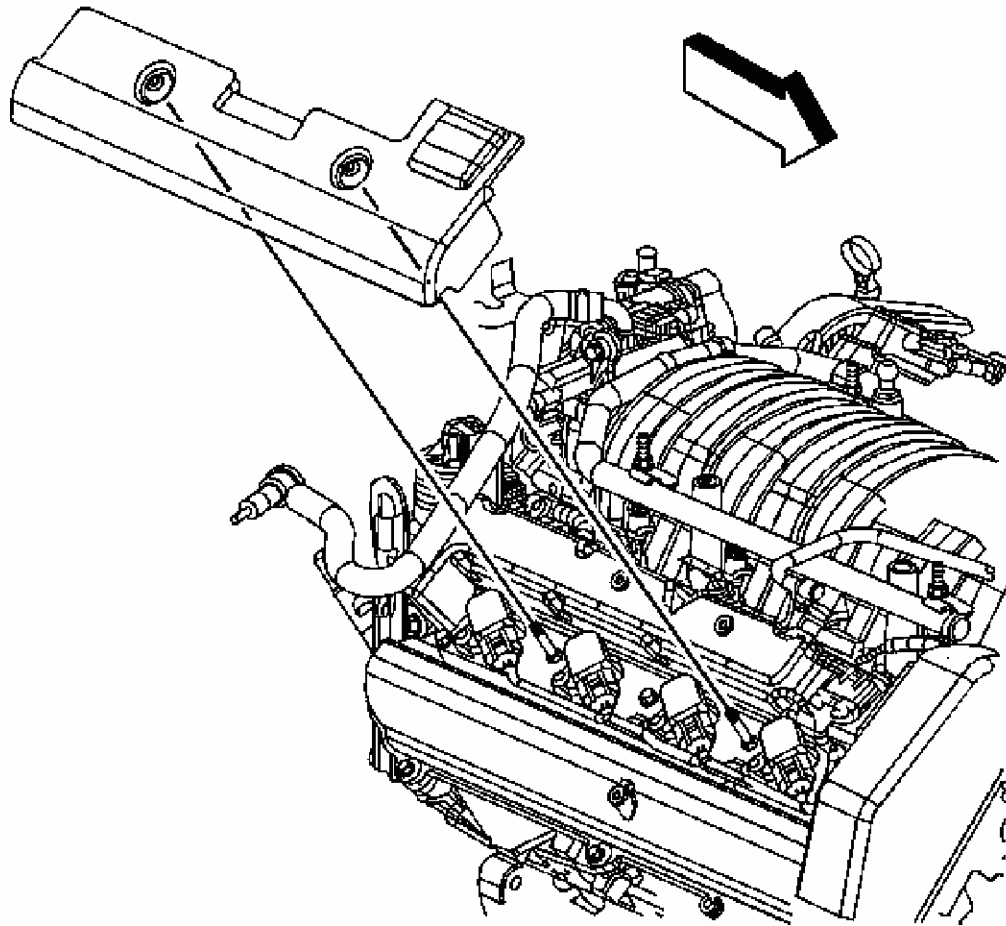


Fig. 51: Identifying Rear Intake Manifold Sight Shield
Courtesy of GENERAL MOTORS CORP.

1. If necessary to install the rear intake manifold sight shield perform the following steps, position the rear intake manifold sight shield cover over the ball studs.
2. Press down on the rear intake manifold sight shield cover over the balls stud in order to engage the cover to the ball studs.
3. Install the AIR check valve. Refer to **Secondary Air Injection Check Valve Replacement** .

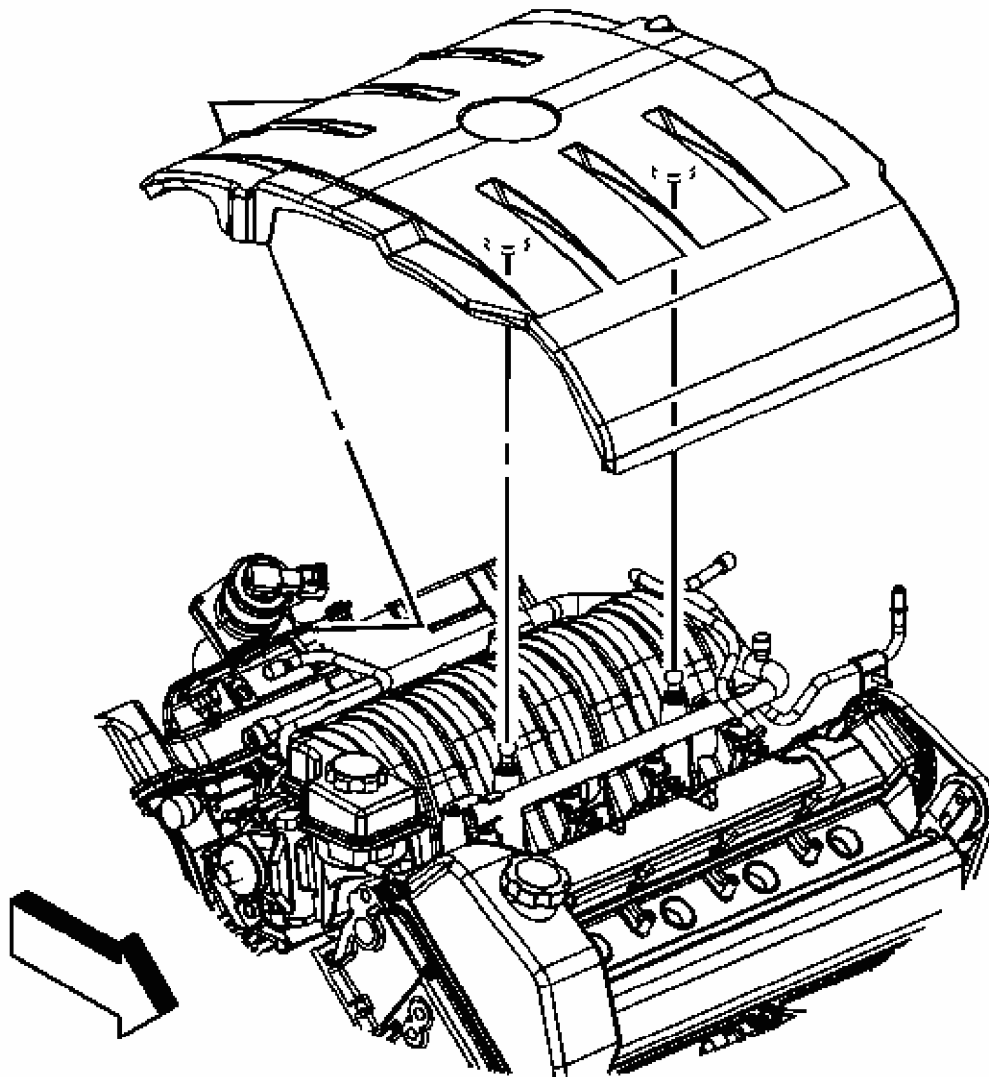


Fig. 52: Identifying Fuel Injector Sight Shield
Courtesy of GENERAL MOTORS CORP.

4. Install the intake manifold sight shield cover under the tab on the AIR check valve bracket.
5. Position the intake manifold sight shield cover over the ball studs.
6. Press down on the intake manifold sight shield cover over the balls stud in order to engage the cover to the ball studs.

CRANKCASE VENTILATION HOSES/PIPES REPLACEMENT

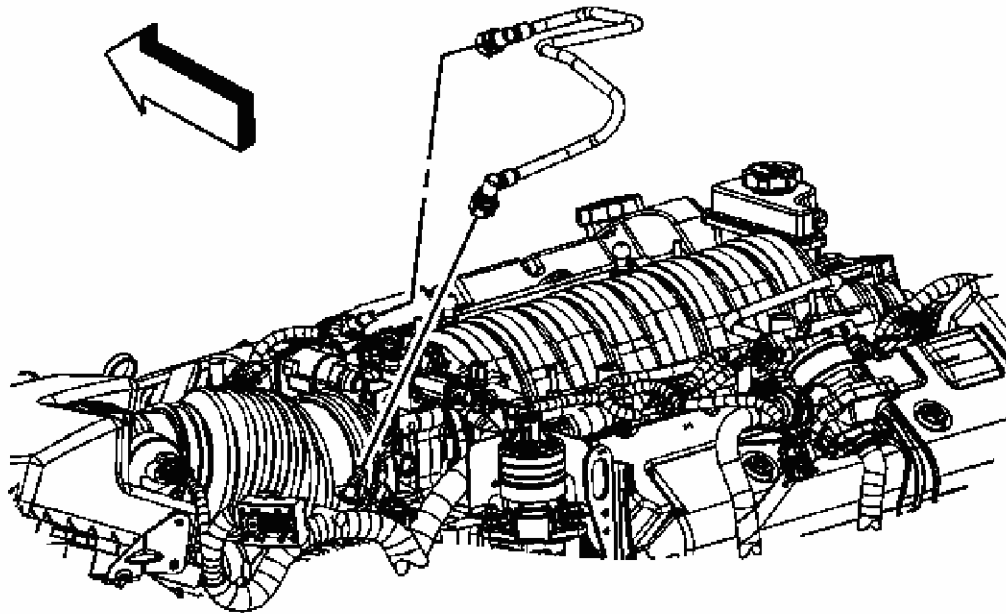
REMOVAL PROCEDURE

Fig. 53: Identifying PCV Fresh Air Tube
Courtesy of GENERAL MOTORS CORP.

1. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.
2. If servicing the positive ventilation crankcase (PCV) fresh air tube, perform the following steps, disconnect the PCV fresh air tube quick connect fitting at the left camshaft cover. Refer to **Plastic Collar Quick Connect Fitting Service**.
3. Disconnect the PCV fresh air tube quick connect fitting at the air cleaner outlet duct. Refer to **Plastic Collar Quick Connect Fitting Service**.
4. Remove the PCV fresh air tube from under the brake booster vacuum hose and evaporative emission (EVAP) purge solenoid.

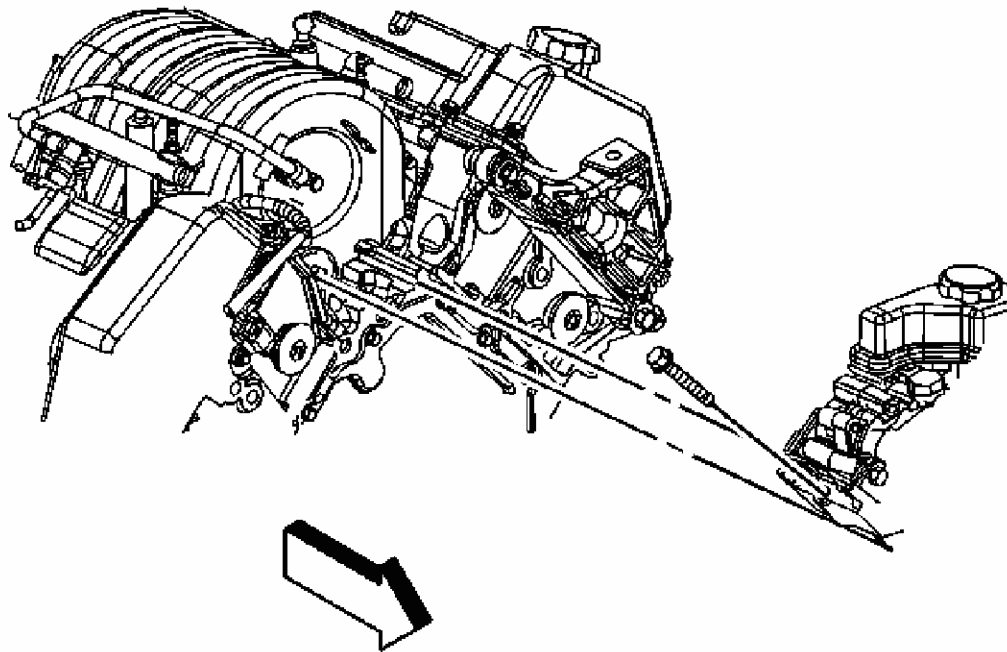


Fig. 54: View Of Power Steering Pump
Courtesy of GENERAL MOTORS CORP.

5. If servicing the PCV foul air tube, perform the following steps, remove the drive belt. Refer to **Drive Belt Replacement**.
6. Remove the power steering pump bolt.
7. With the power steering hoses attached, Carefully position the power steering pump aside.

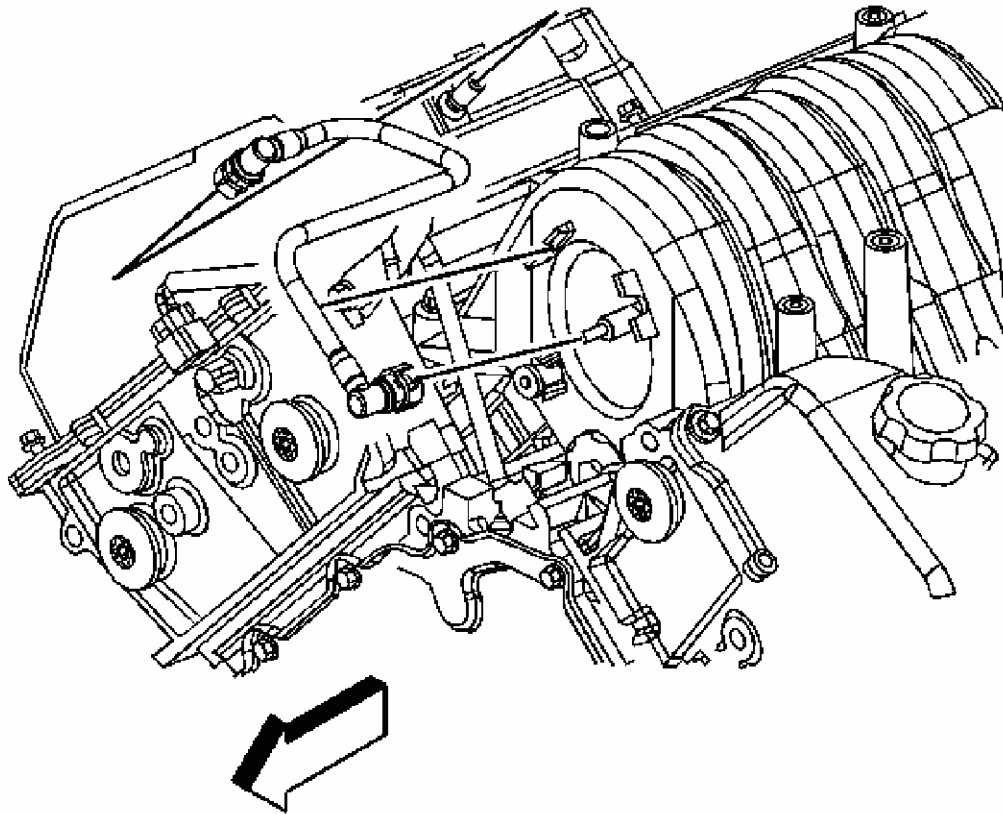


Fig. 55: Identifying PCV Foul Air Tube Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

8. Disconnect the PCV foul air tube quick connect fitting at the right camshaft cover. Refer to **Plastic Collar Quick Connect Fitting Service** .
9. Disconnect the PCV foul air tube quick connect fitting at the intake manifold fitting. Refer to **Plastic Collar Quick Connect Fitting Service** .
10. Remove the PCV foul air tube from the retaining features on the intake manifold.

INSTALLATION PROCEDURE

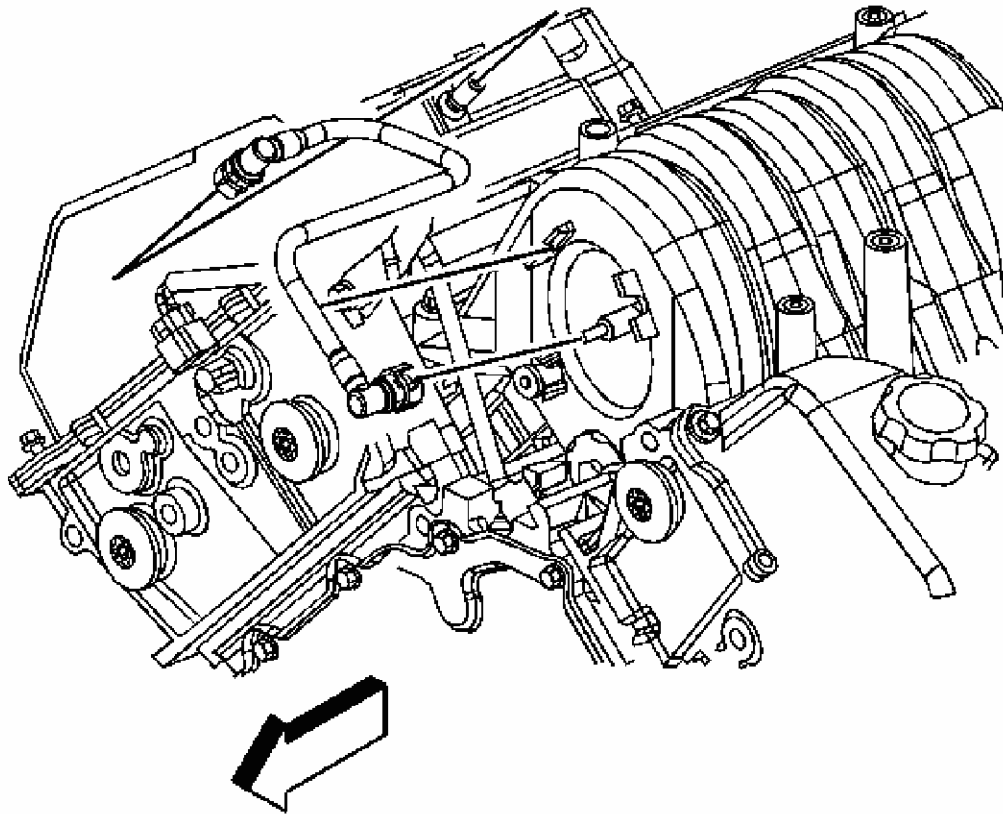


Fig. 56: Identifying PCV Foul Air Tube Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

1. If servicing the PCV foul air tube, perform the following steps, connect the PCV foul air tube quick connect fitting to the right camshaft cover. Refer to **Plastic Collar Quick Connect Fitting Service** .
2. Connect the PCV foul air tube quick connect fitting at the intake manifold fitting. Refer to **Plastic Collar Quick Connect Fitting Service** .
3. Install the PCV foul air tube to the retaining features on the intake manifold.

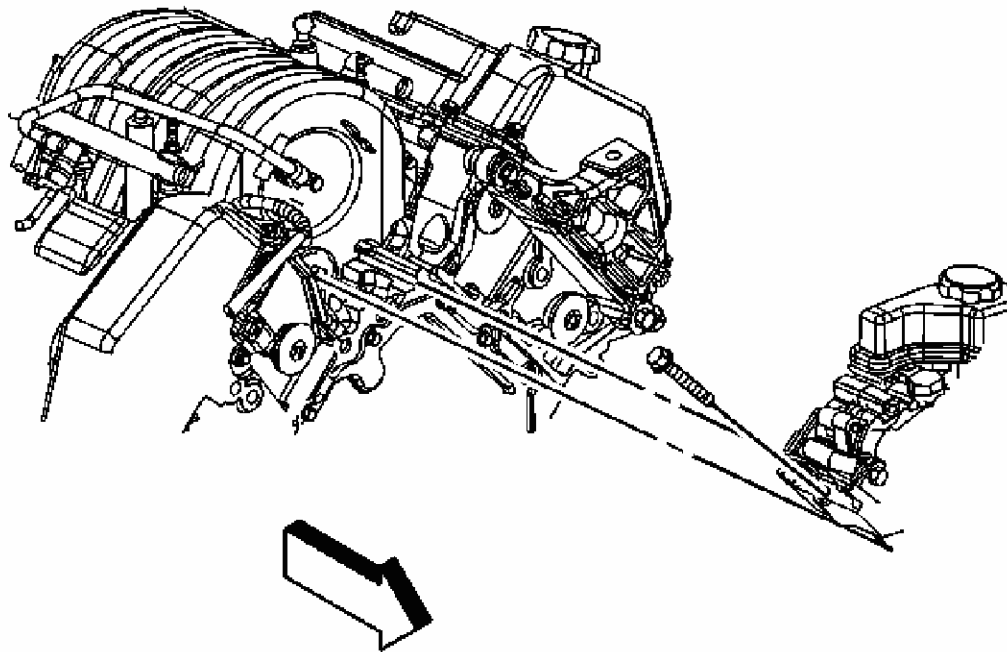


Fig. 57: View Of Power Steering Pump
Courtesy of GENERAL MOTORS CORP.

4. Install the power steering pump into position.

NOTE: Refer to Fastener Notice .

5. Install the power steering pump bolt.

Tighten: Tighten the bolt to 50 N.m (37 lb ft).

6. Install the drive belt. Refer to Drive Belt Replacement.

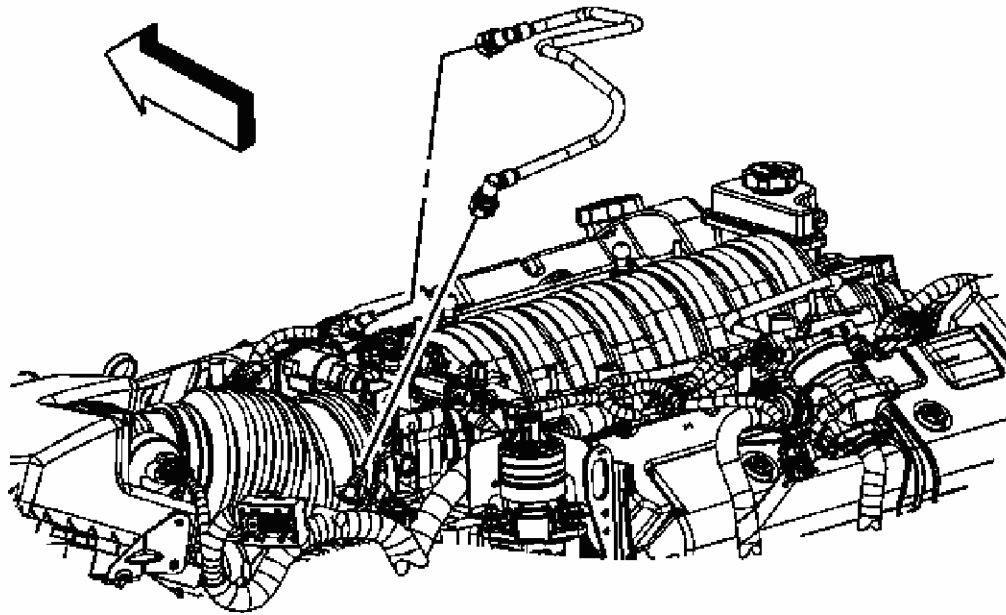


Fig. 58: Identifying PCV Fresh Air Tube
Courtesy of GENERAL MOTORS CORP.

7. If servicing the PCV fresh air tube, perform the following steps, route the PCV fresh air tube under the brake booster vacuum hose and EVAP purge solenoid.
8. Connect the PCV fresh air tube quick connect fitting at the air cleaner outlet duct. Refer to **Plastic Collar Quick Connect Fitting Service** .
9. Connect the PCV fresh air tube quick connect fitting at the left camshaft cover. Refer to **Plastic Collar Quick Connect Fitting Service** .
10. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.

INTAKE MANIFOLD REPLACEMENT

REMOVAL PROCEDURE

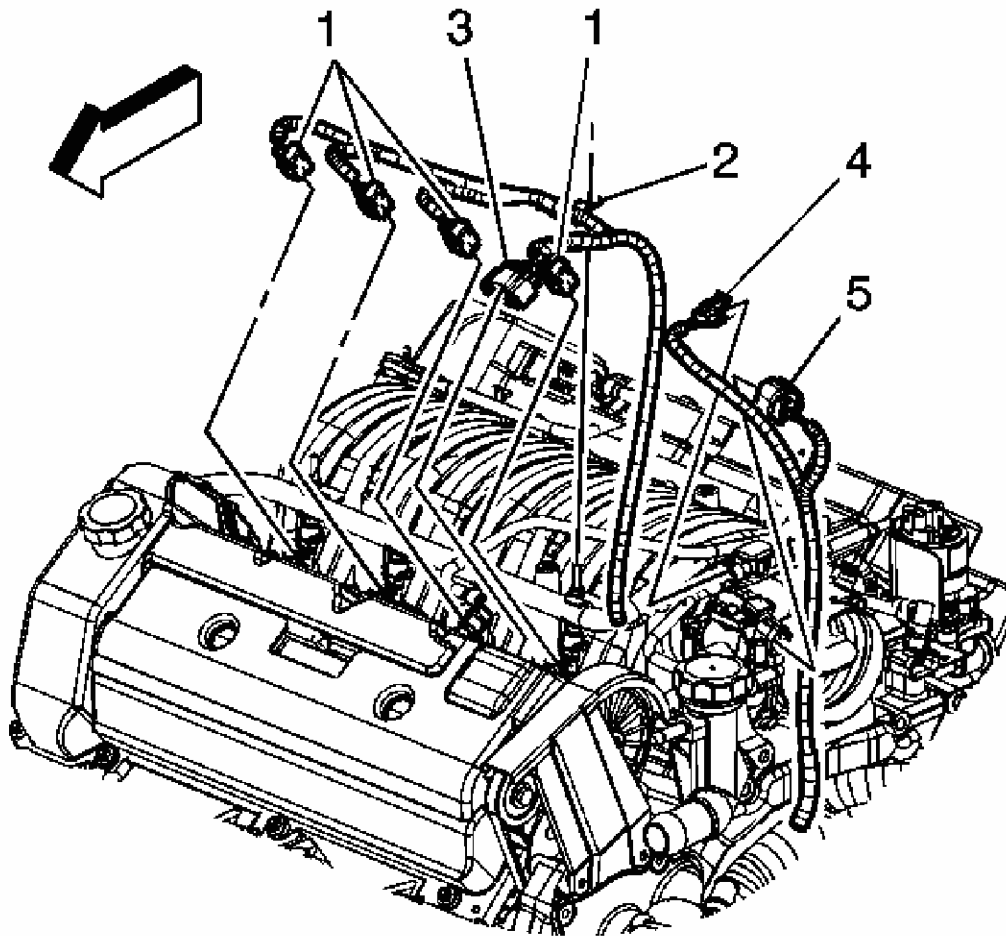


Fig. 59: Identifying Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

1. Remove the fuel injector sight shield cover. Refer to **Fuel Injector Sight Shield Replacement**.
2. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.
3. Disconnect the front ignition coil module engine harness electrical connector (3).
4. Disconnect the front fuel injectors engine harness electrical connectors (1).

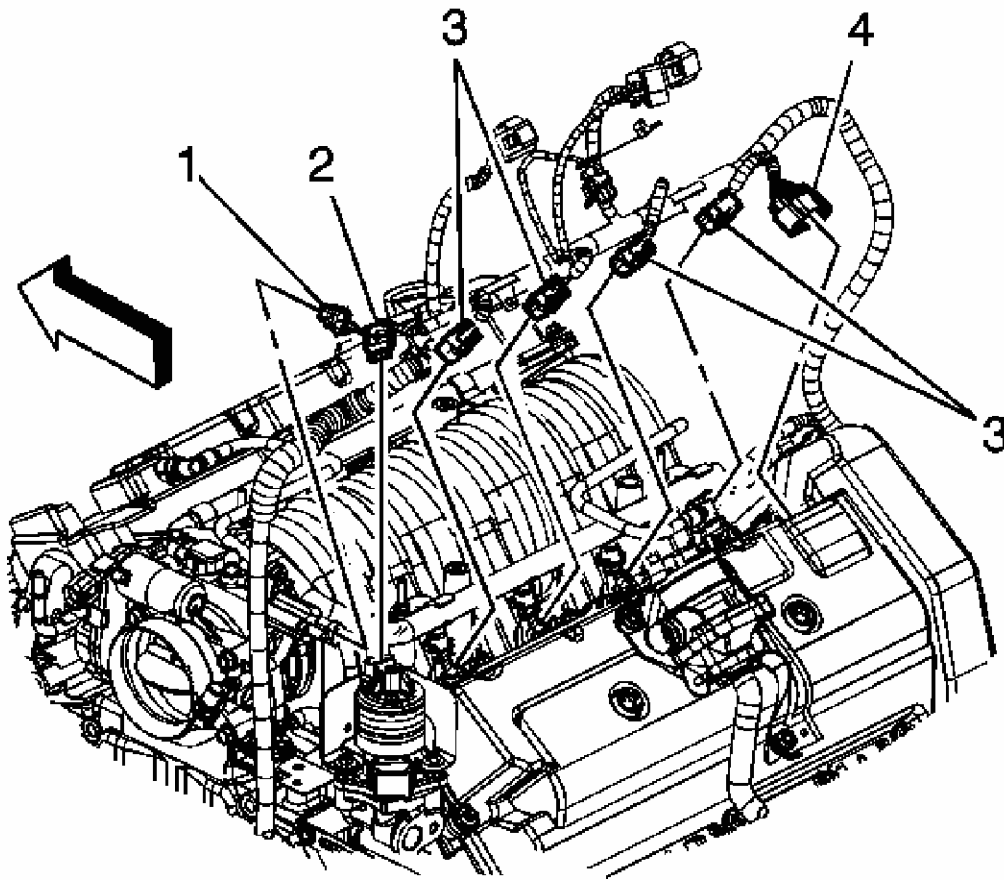


Fig. 60: Locating Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

5. Disconnect the rear ignition coil module engine harness electrical connector (4).
6. Disconnect the rear fuel injectors engine harness electrical connectors (3).

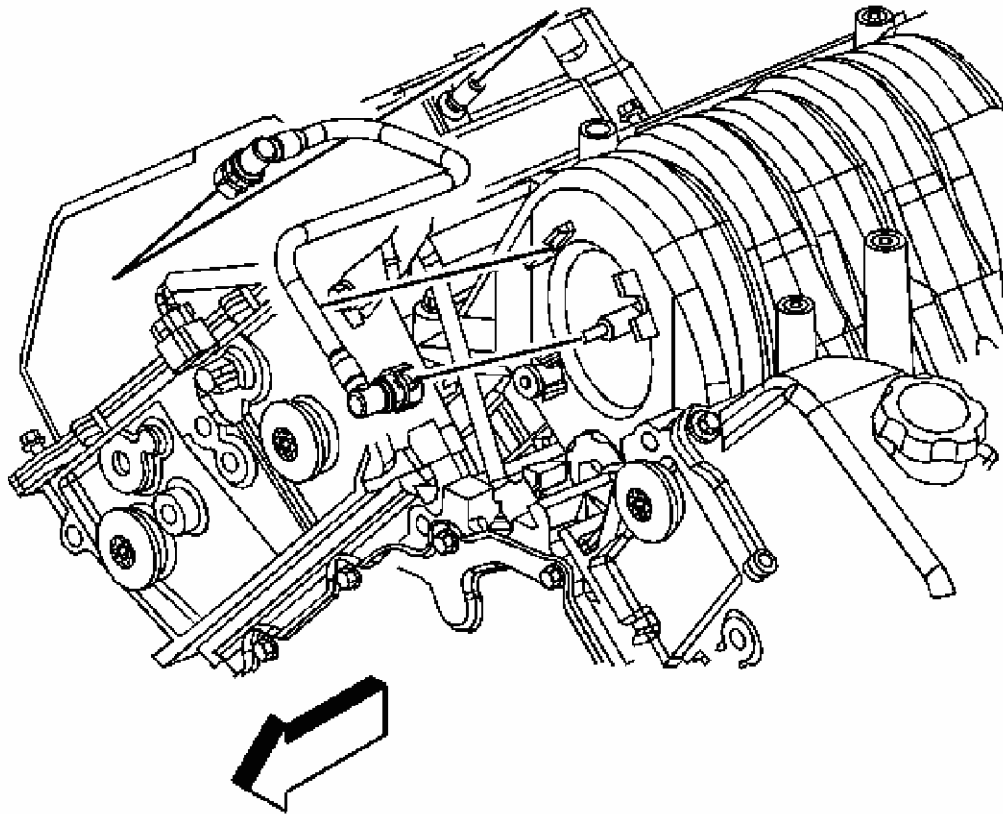


Fig. 61: Identifying PCV Foul Air Tube Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

7. Disconnect the positive crankcase ventilation (PCV) foul air tube quick connect fitting from the right camshaft cover. Refer to **Plastic Collar Quick Connect Fitting Service** .

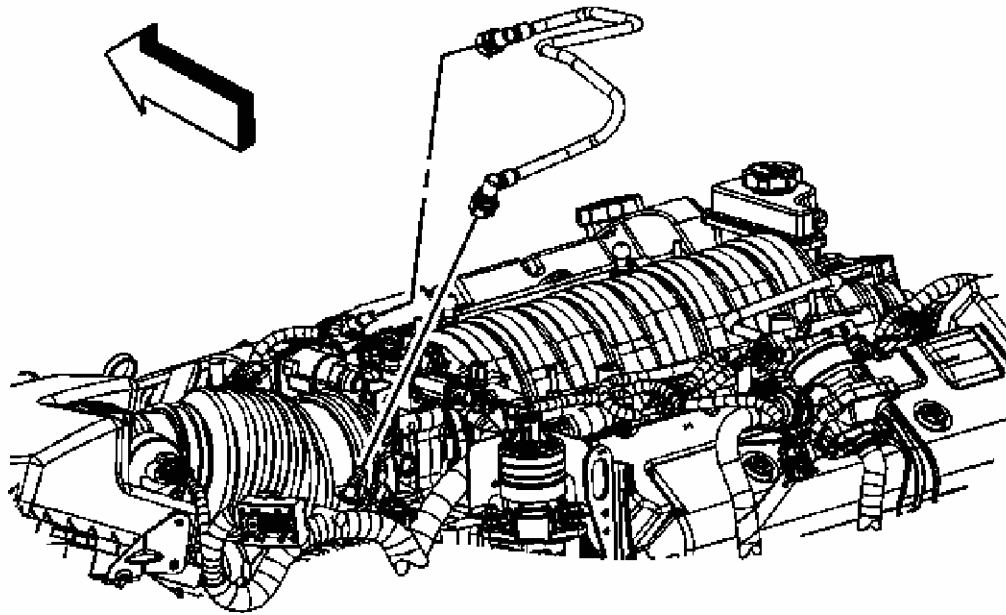


Fig. 62: Identifying PCV Fresh Air Tube
Courtesy of GENERAL MOTORS CORP.

8. Disconnect the PCV fresh air tube quick connect fitting from the camshaft cover. Refer to **Plastic Collar Quick Connect Fitting Service** .

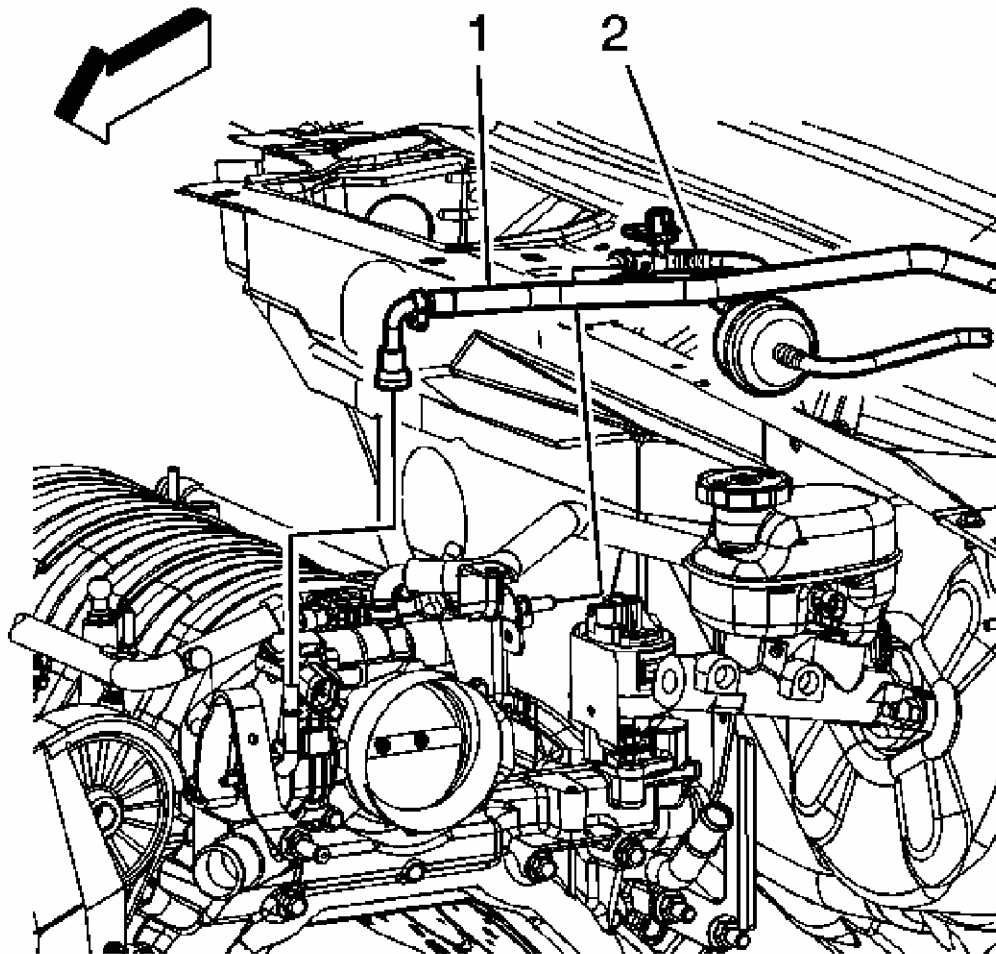


Fig. 63: Identifying Fuel Feed Pipe & EVAP Line Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

9. Disconnect the fuel feed line (1) quick connect fitting at the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service** .

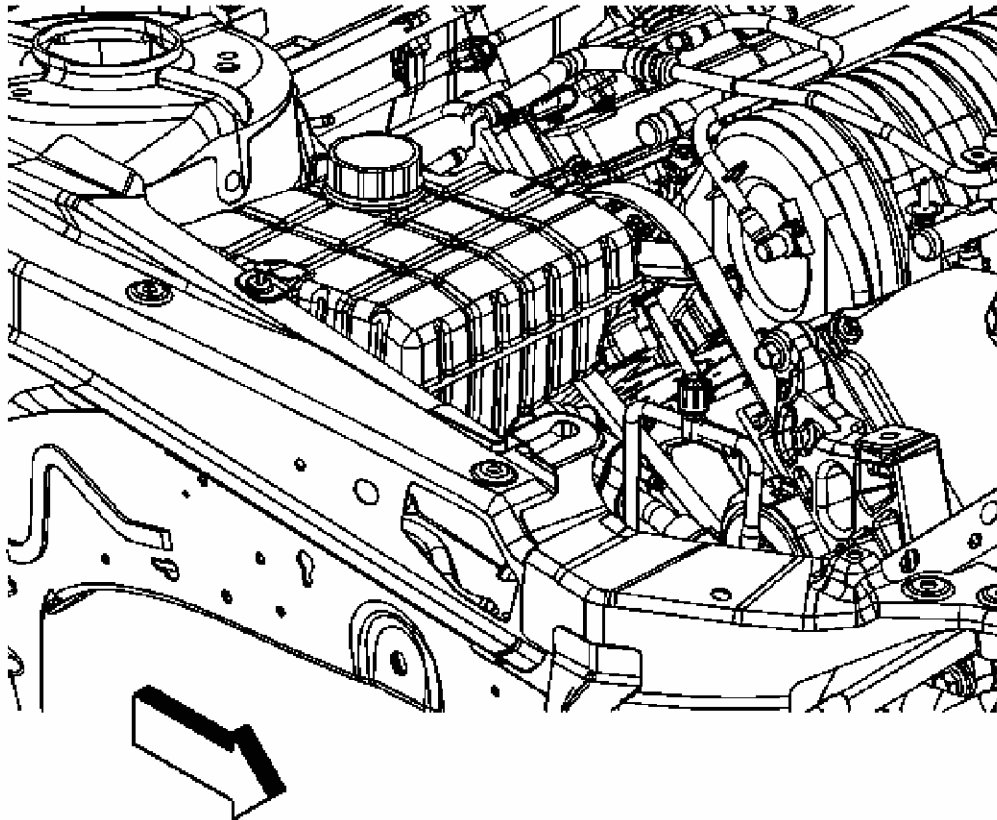


Fig. 64: Identifying Surge Tank Inlet Hose/Pipe
Courtesy of GENERAL MOTORS CORP.

10. Reposition the radiator surge tank inlet hose/pipe clamp at the surge tank.
11. Remove the surge tank inlet hose/pipe from the surge tank.

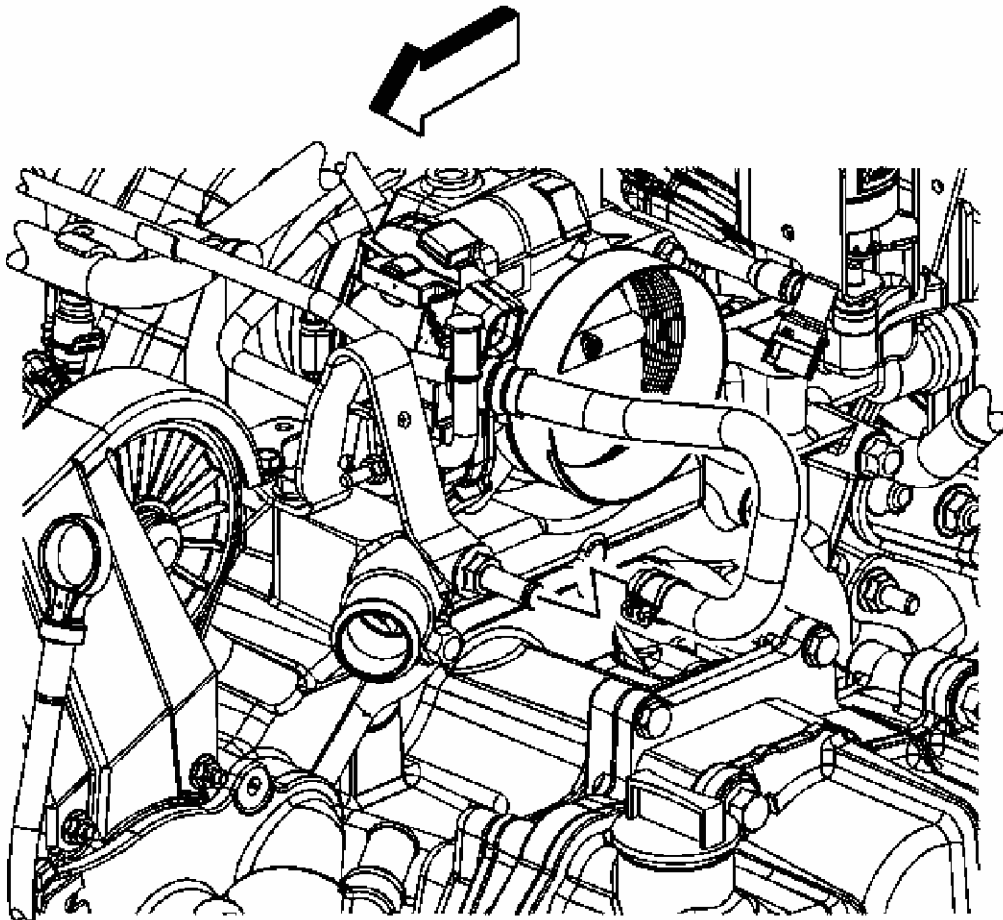


Fig. 65: View Of Surge Tank Inlet Hose/Pipe
Courtesy of GENERAL MOTORS CORP.

12. Reposition the radiator surge tank inlet hose/pipe clamp at the engine.
13. Remove the surge tank inlet hose/pipe from the engine fitting.

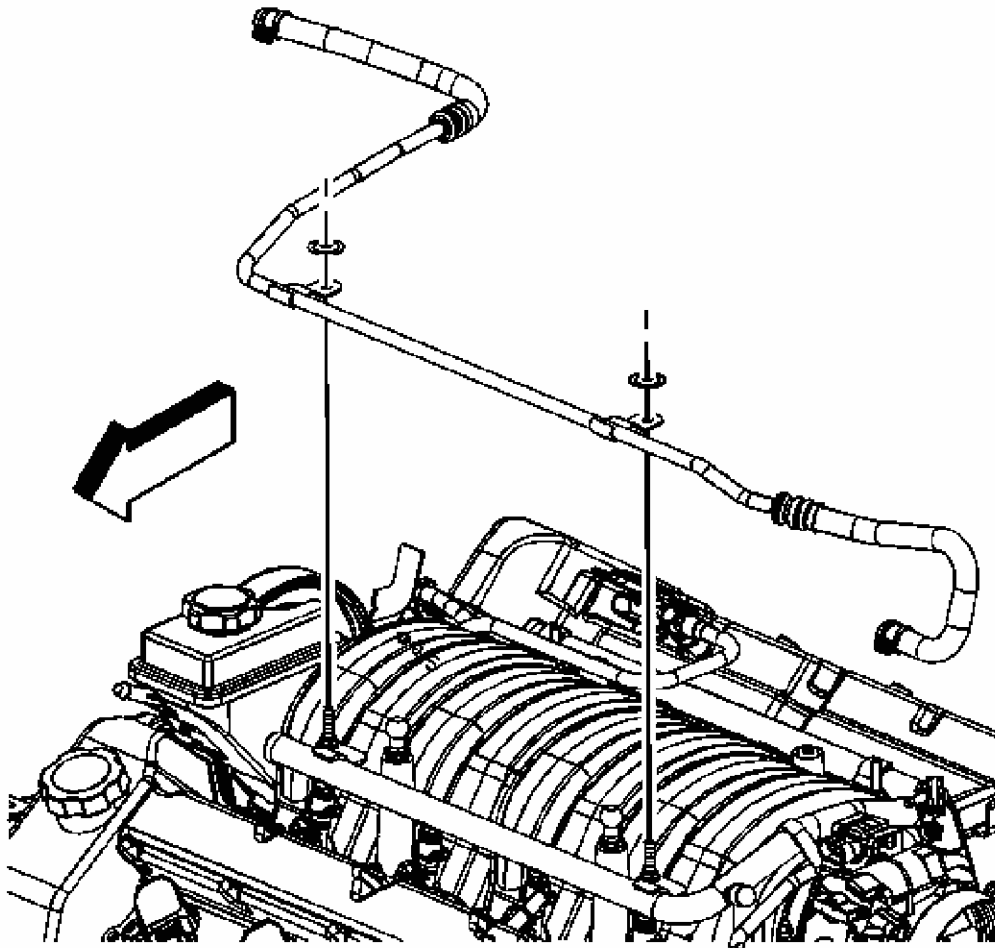


Fig. 66: Identifying Surge Tank Inlet Hose/Pipe & Clips
Courtesy of GENERAL MOTORS CORP.

14. Remove the 2 pushnuts securing the surge tank inlet hose/pipe to the fuel rail studs.
15. Remove the surge tank inlet hose/pipe from the fuel rail studs.
16. Remove the engine harness retainer from the fuel rail stud.

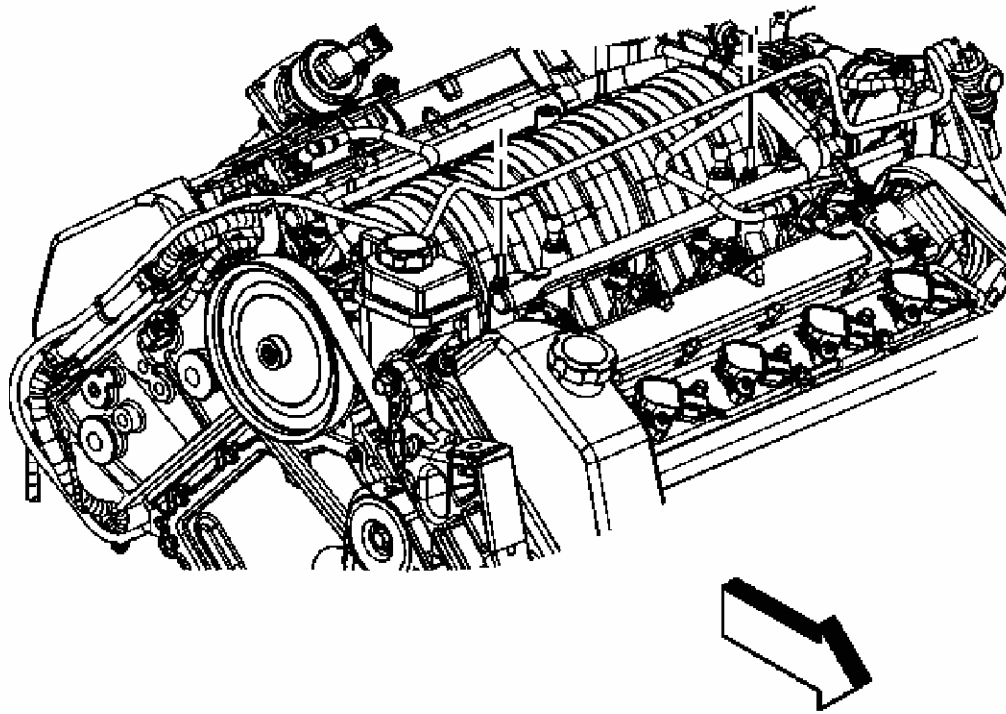


Fig. 67: Locating Coolant Heater Cord Tabs
Courtesy of GENERAL MOTORS CORP.

17. Remove the coolant heater cord tabs from the fuel rail studs, if equipped.

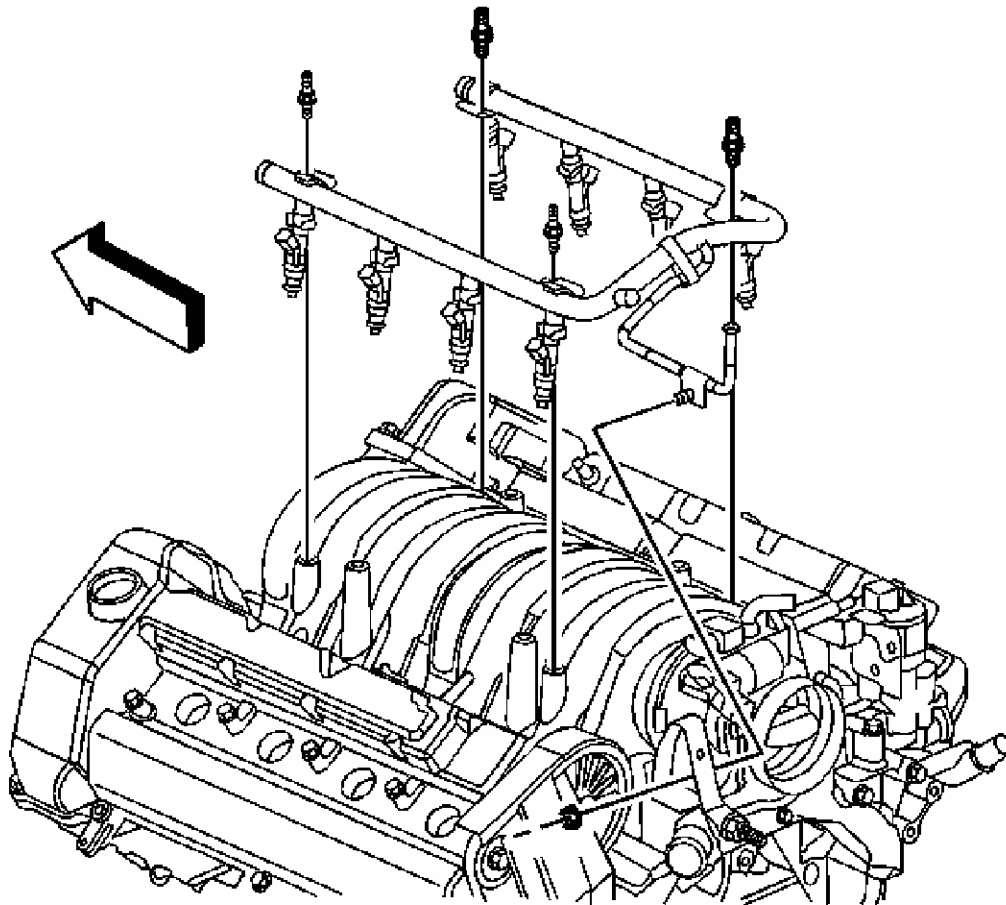


Fig. 68: View Of Fuel Rail, Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

18. Remove the fuel rail bracket nut at the rear left lift bracket.
19. Remove the fuel rail studs.
20. Remove the fuel rail.

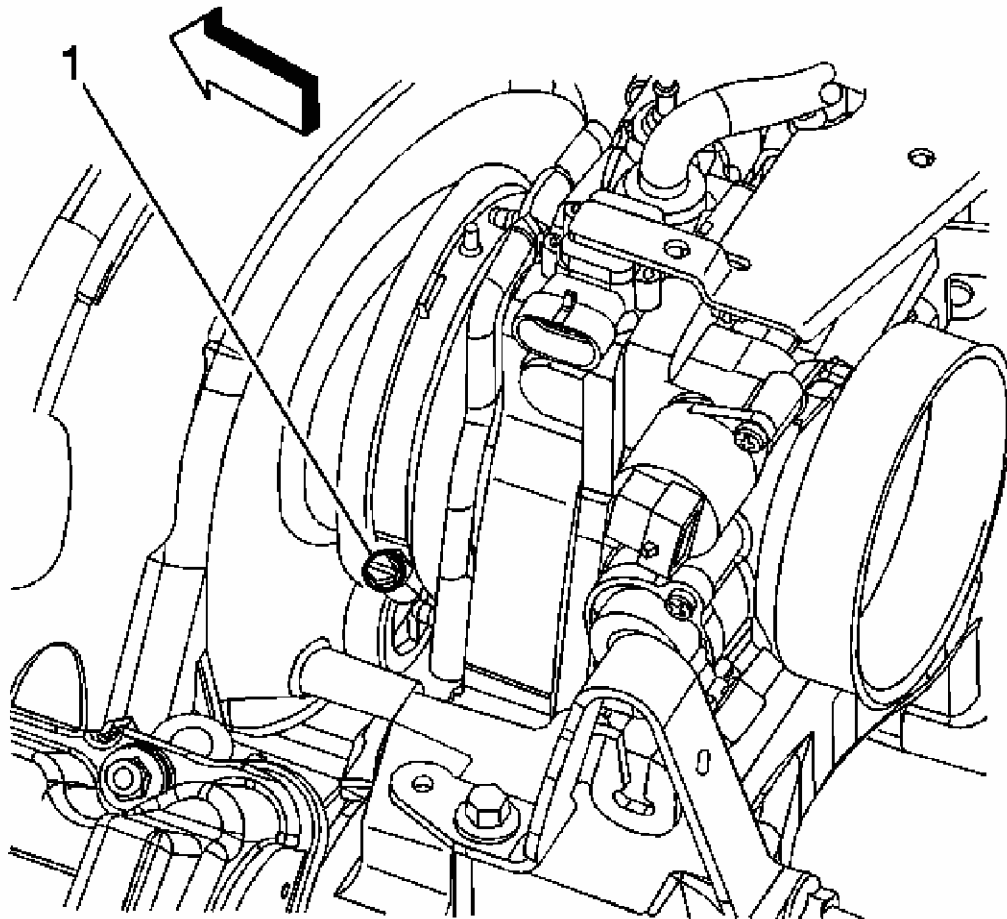


Fig. 69: Locating Plenum Duct Clamp Screw
Courtesy of GENERAL MOTORS CORP.

21. Loosen the plenum duct clamp screw (1) at the water pump housing.

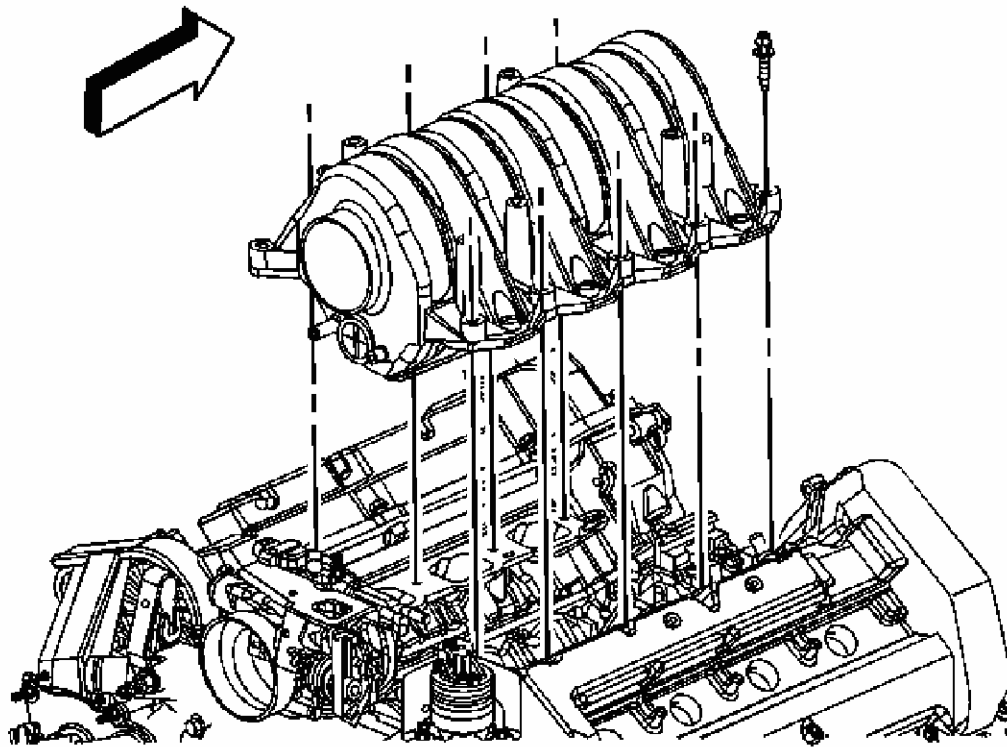


Fig. 70: Intake Manifold
Courtesy of GENERAL MOTORS CORP.

22. Remove intake manifold bolts.
23. Remove the intake manifold.
24. Disconnect the PCV foul air tube quick connect fitting at the intake manifold. Refer to **Plastic Collar Quick Connect Fitting Service** .
25. Remove the PCV foul air tube from the retaining features on the intake manifold.
26. Remove and discard the old seals.
27. Clean and inspect the intake manifold. Refer to **Intake Manifold Cleaning and Inspection** .

INSTALLATION PROCEDURE

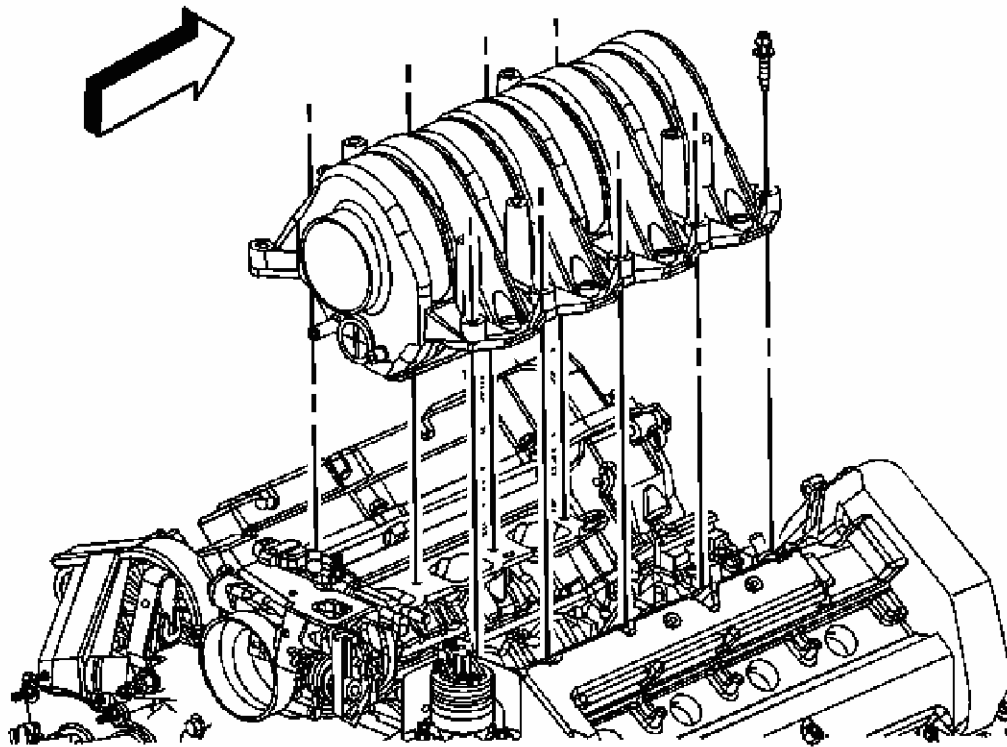


Fig. 71: Intake Manifold

Courtesy of GENERAL MOTORS CORP.

1. Install the new intake manifold seals.
2. Connect the PCV foul air tube quick connect fitting at the intake manifold. Refer to **Plastic Collar Quick Connect Fitting Service** .
3. Install the PCV foul air tube to the retaining features on the intake manifold.
4. Lightly grease the inside edge of the rubber plenum duct on the water pump housing.
5. Install the intake manifold.
6. Install intake manifold bolts until snug.

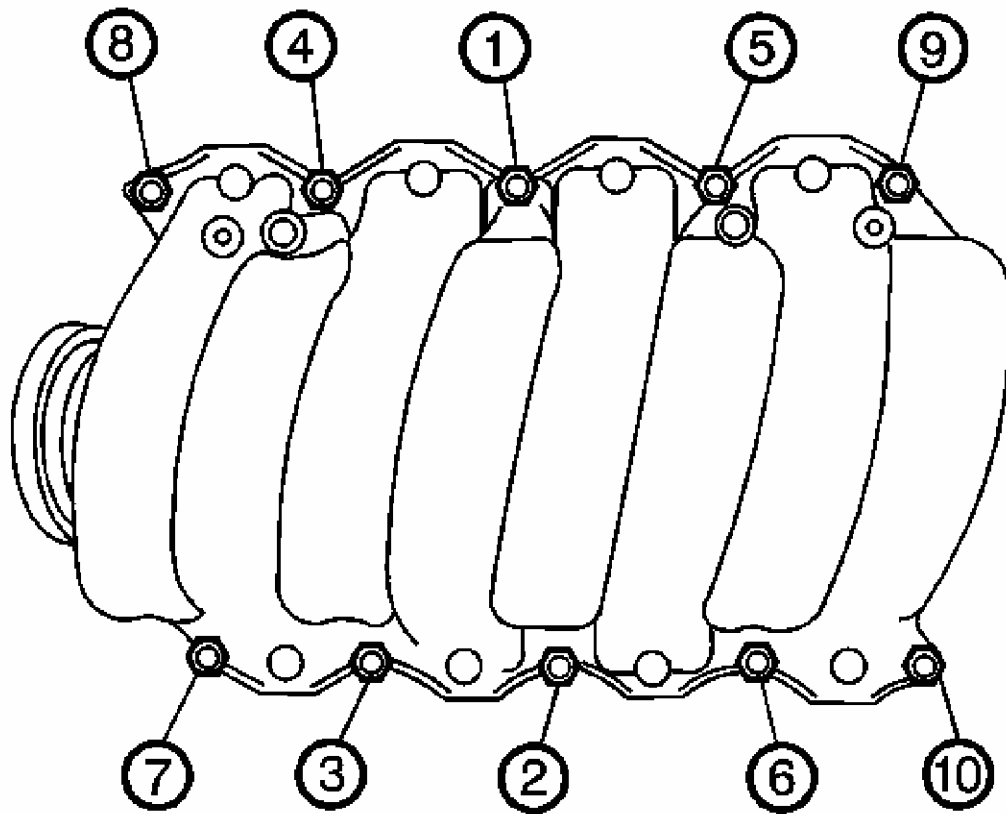


Fig. 72: View of Intake Manifold Bolt Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

7. Tighten the intake manifold bolts.

Tighten: Tighten the bolts in the sequence shown to 10 N.m (89 lb in).

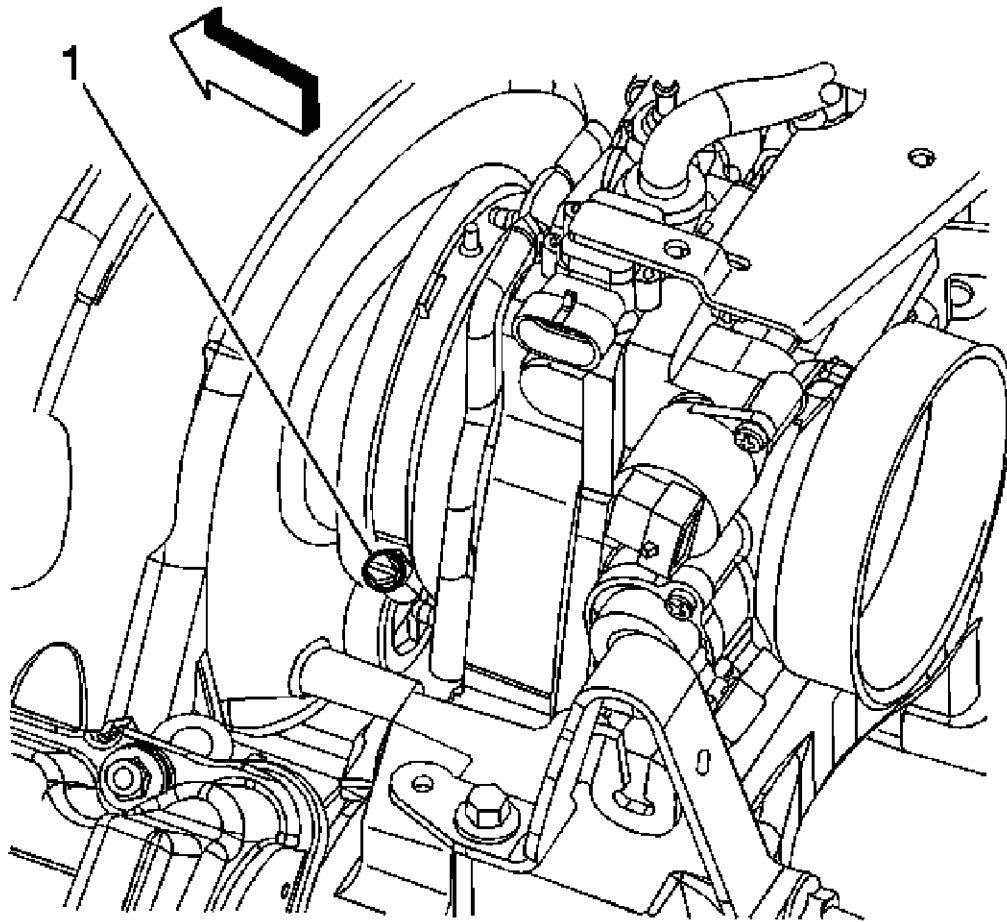


Fig. 73: Locating Plenum Duct Clamp Screw
Courtesy of GENERAL MOTORS CORP.

8. Ensure that the intake manifold is fully installed into the plenum duct on the water pump housing.
9. Tighten the plenum duct clamp screw (1) at the water pump housing.

Tighten: Tighten the screw to 2.75 N.m (24 lb in).

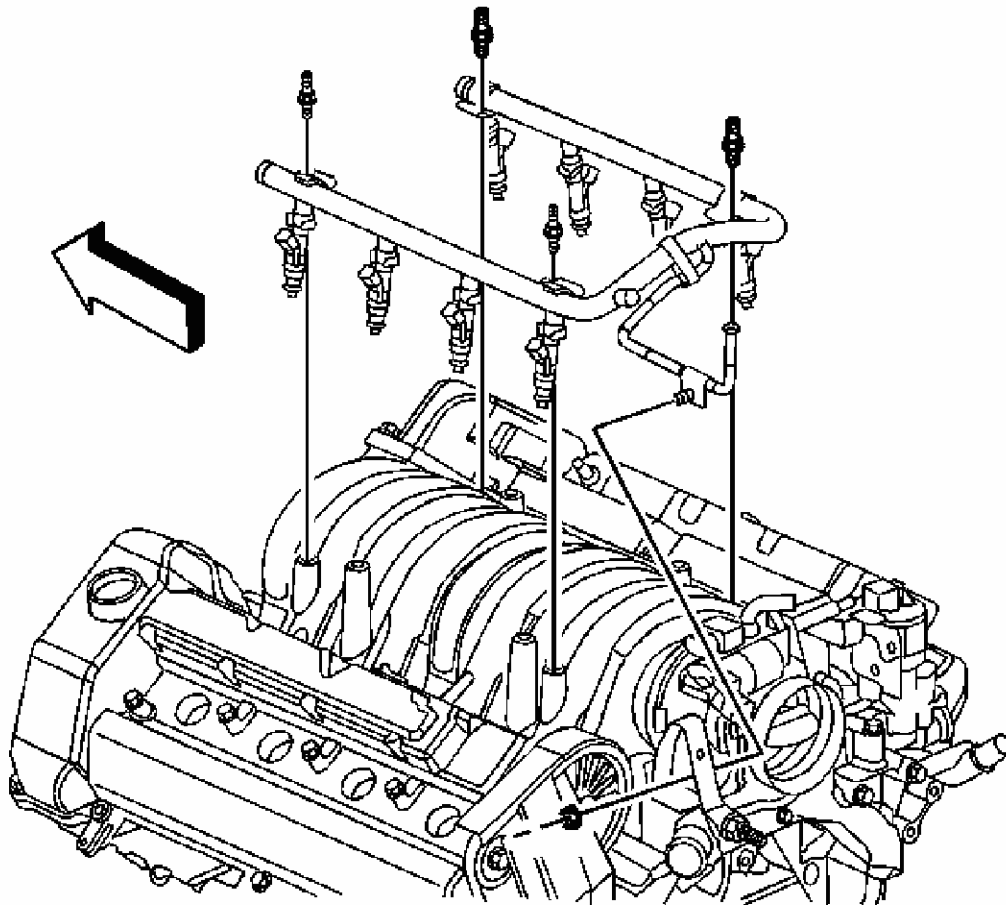


Fig. 74: View Of Fuel Rail, Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

10. Lubricate the fuel injector lower O-ring seals with clean engine oil.
11. Install the fuel rail.
12. Install the fuel rail studs.

Tighten: Tighten the studs to 10 N.m (89 lb in).

13. Install the fuel rail bracket nut at the rear left lift bracket.

Tighten: Tighten the nut to 10 N.m (89 lb in).

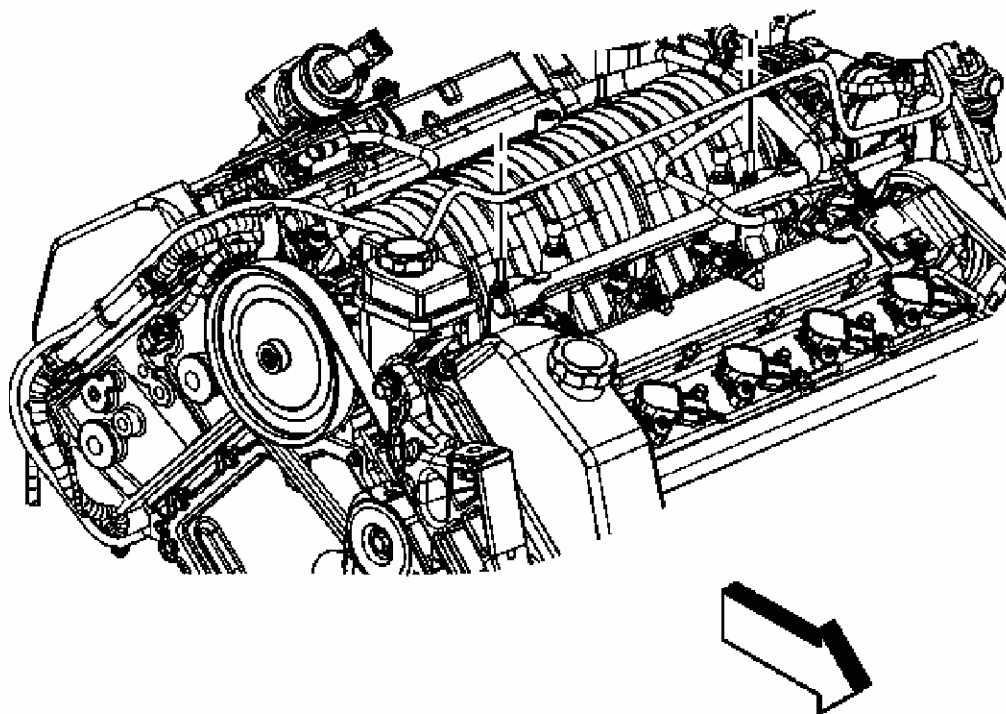


Fig. 75: Locating Coolant Heater Cord Tabs
Courtesy of GENERAL MOTORS CORP.

14. Install the coolant heater cord tabs to the fuel rail studs, if equipped.

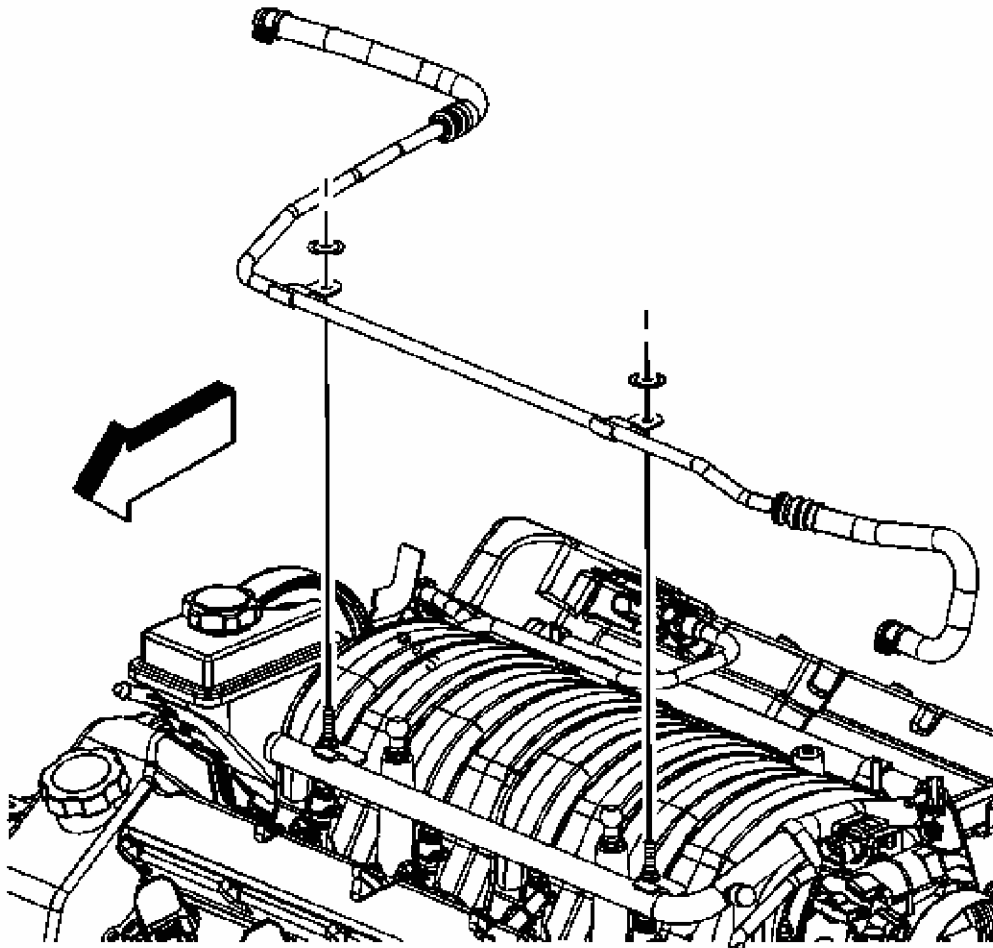


Fig. 76: Identifying Surge Tank Inlet Hose/Pipe & Clips
Courtesy of GENERAL MOTORS CORP.

15. Install the engine harness retainer to the fuel rail stud.
16. Install the surge tank inlet hose/pipe to the fuel rail studs.
17. Install the 2 pushnuts securing the surge tank inlet hose/pipe to the fuel rail studs.

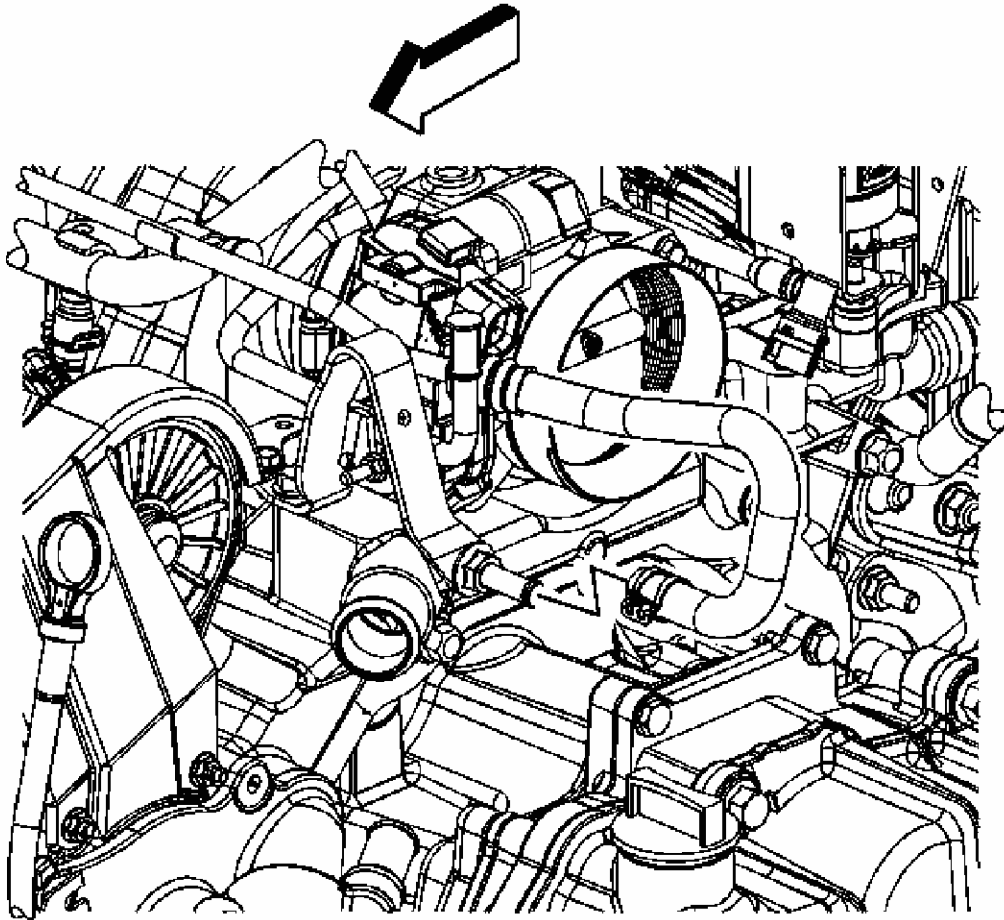


Fig. 77: View Of Surge Tank Inlet Hose/Pipe
Courtesy of GENERAL MOTORS CORP.

18. Install the surge tank inlet hose/pipe to the engine fitting.
19. Position the radiator surge tank inlet hose/pipe clamp at the engine.

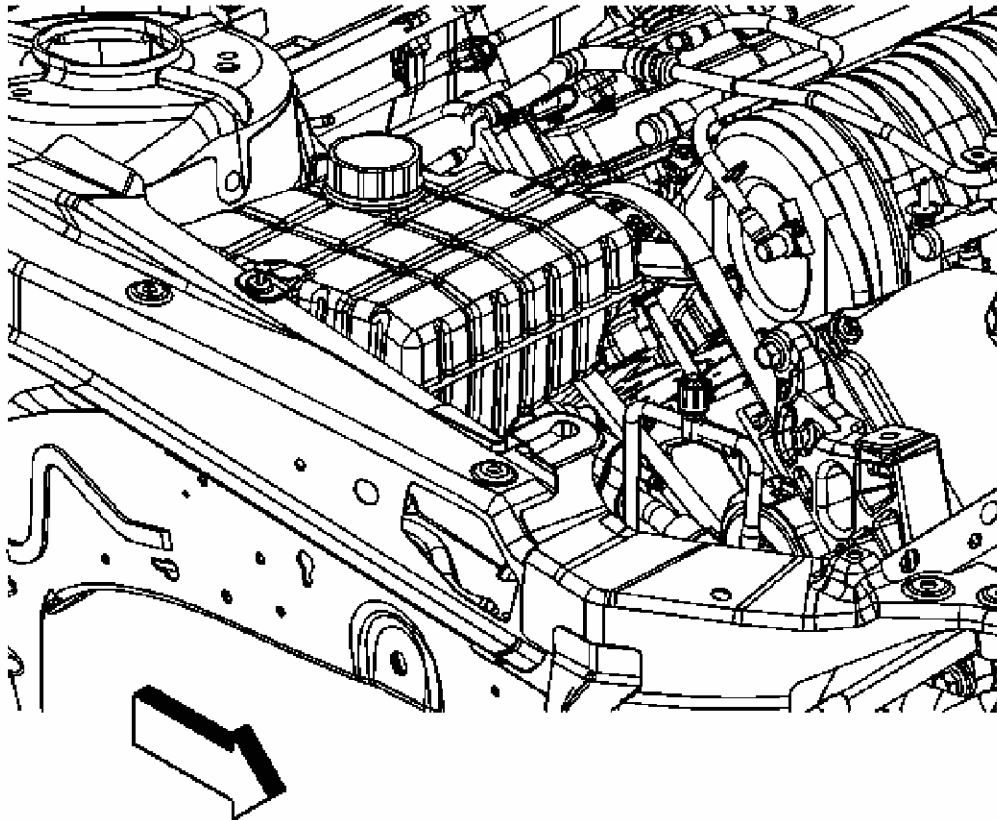


Fig. 78: Identifying Surge Tank Inlet Hose/Pipe
Courtesy of GENERAL MOTORS CORP.

20. Install the surge tank inlet hose/pipe to the surge tank.
21. Position the radiator surge tank inlet hose/pipe clamp at the surge tank.

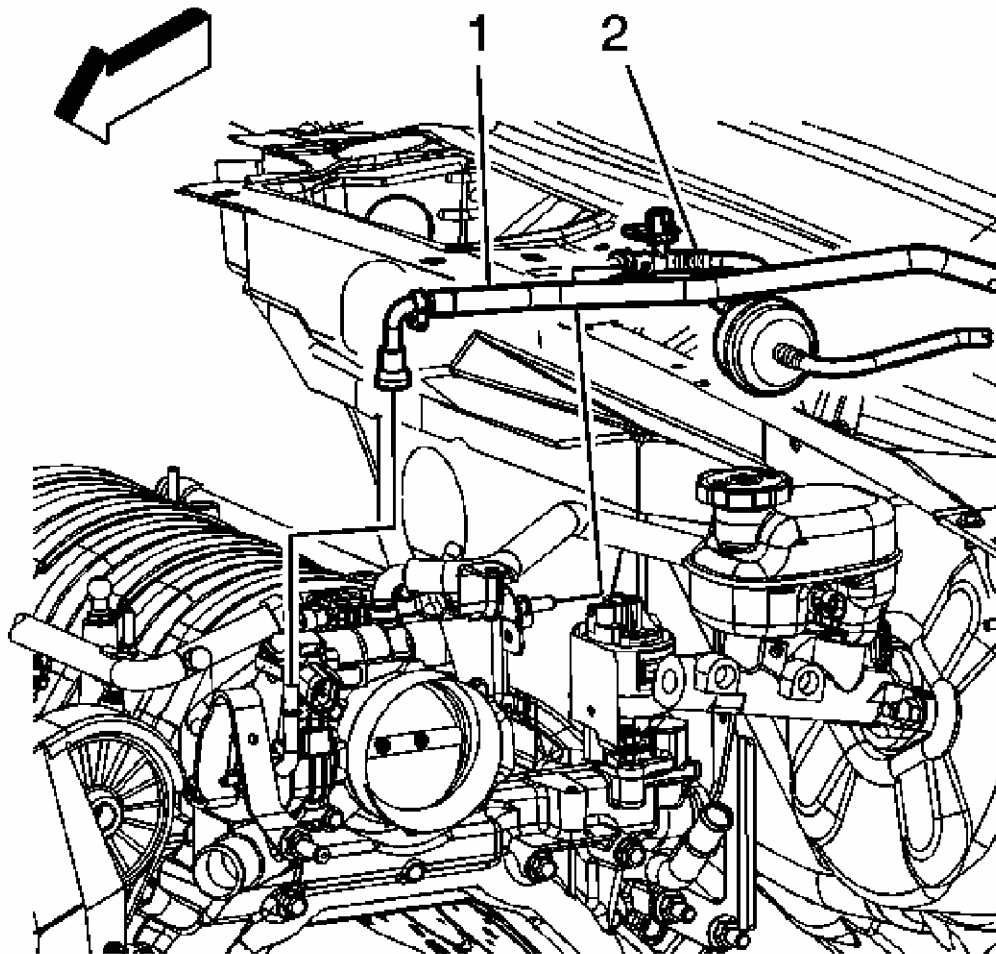


Fig. 79: Identifying Fuel Feed Pipe & EVAP Line Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

22. Connect the fuel feed line (1) quick connect fitting at the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service** .

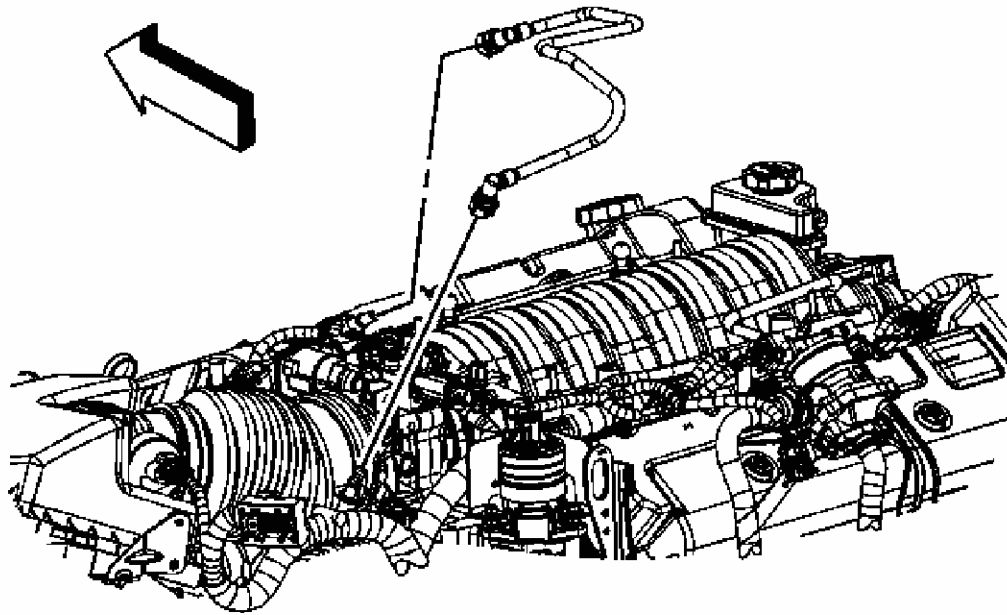


Fig. 80: Identifying PCV Fresh Air Tube
Courtesy of GENERAL MOTORS CORP.

23. Connect the PCV fresh air tube quick connect fitting to the camshaft cover. Refer to **Plastic Collar Quick Connect Fitting Service** .

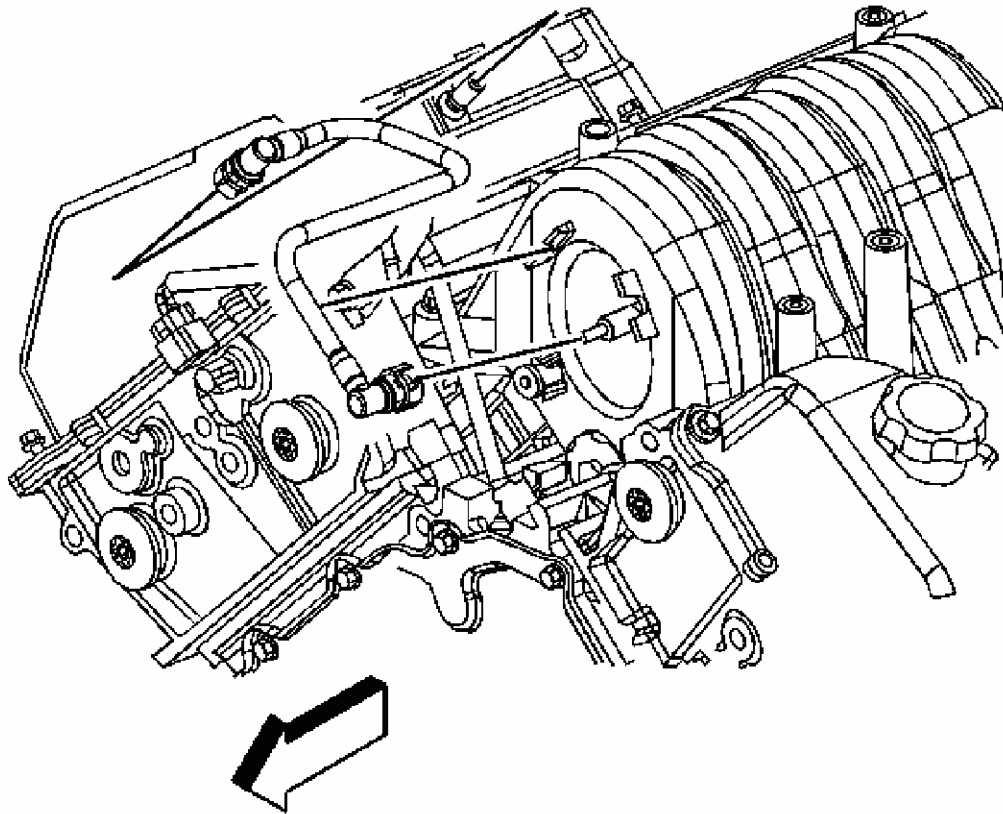


Fig. 81: Identifying PCV Foul Air Tube Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

24. Connect the PCV foul air tube quick connect fitting to the right camshaft cover. Refer to **Plastic Collar Quick Connect Fitting Service**

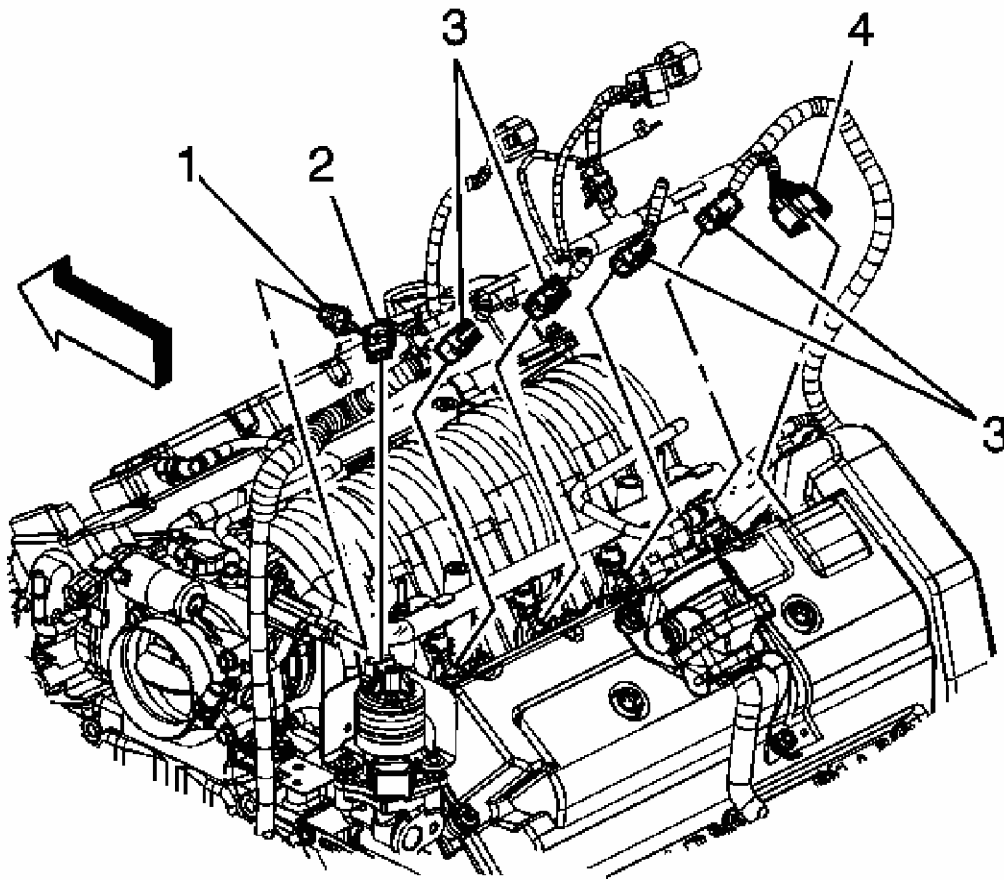


Fig. 82: Locating Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

25. Connect the rear fuel injectors engine harness electrical connectors (3).
26. Connect the rear ignition coil module engine harness electrical connector (4)

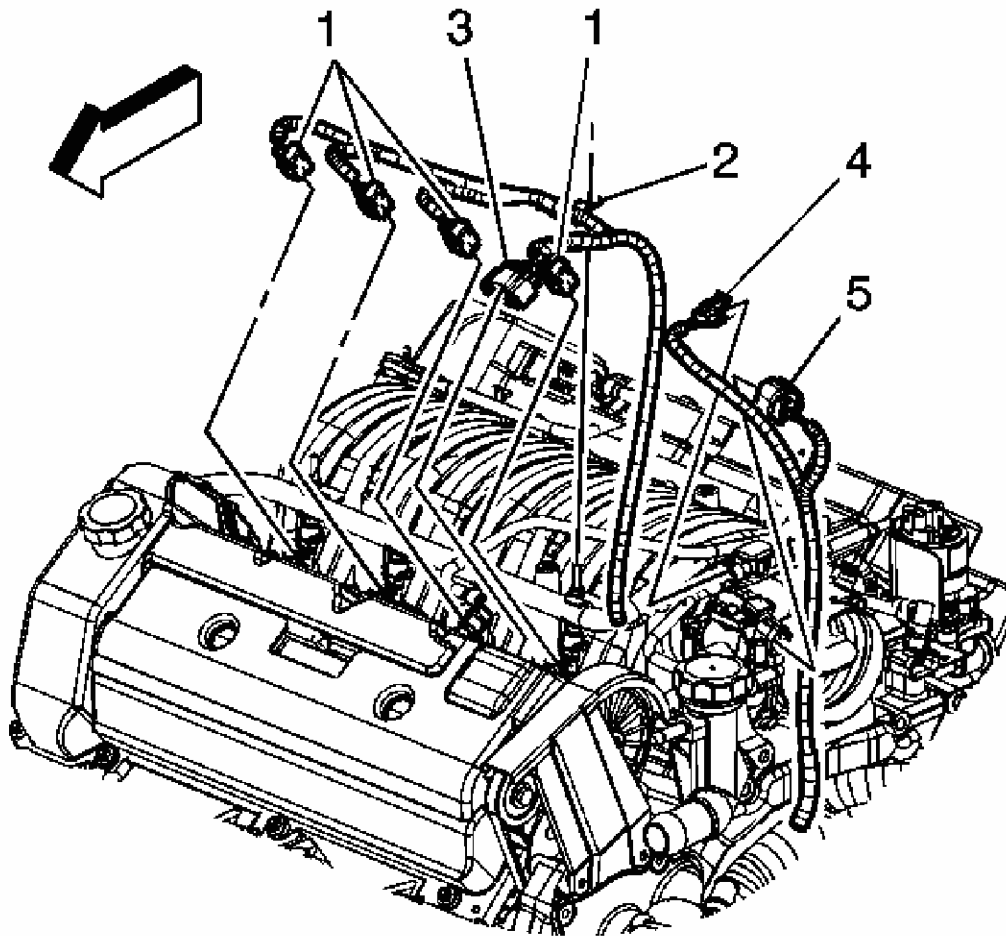


Fig. 83: Identifying Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

27. Connect the front fuel injectors engine harness electrical connectors (1).
28. Connect the front ignition coil module engine harness electrical connector (3).
29. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
30. Install the fuel injector sight shield cover. Refer to **Fuel Injector Sight Shield Replacement**.

OIL LEVEL INDICATOR AND TUBE REPLACEMENT

REMOVAL PROCEDURE

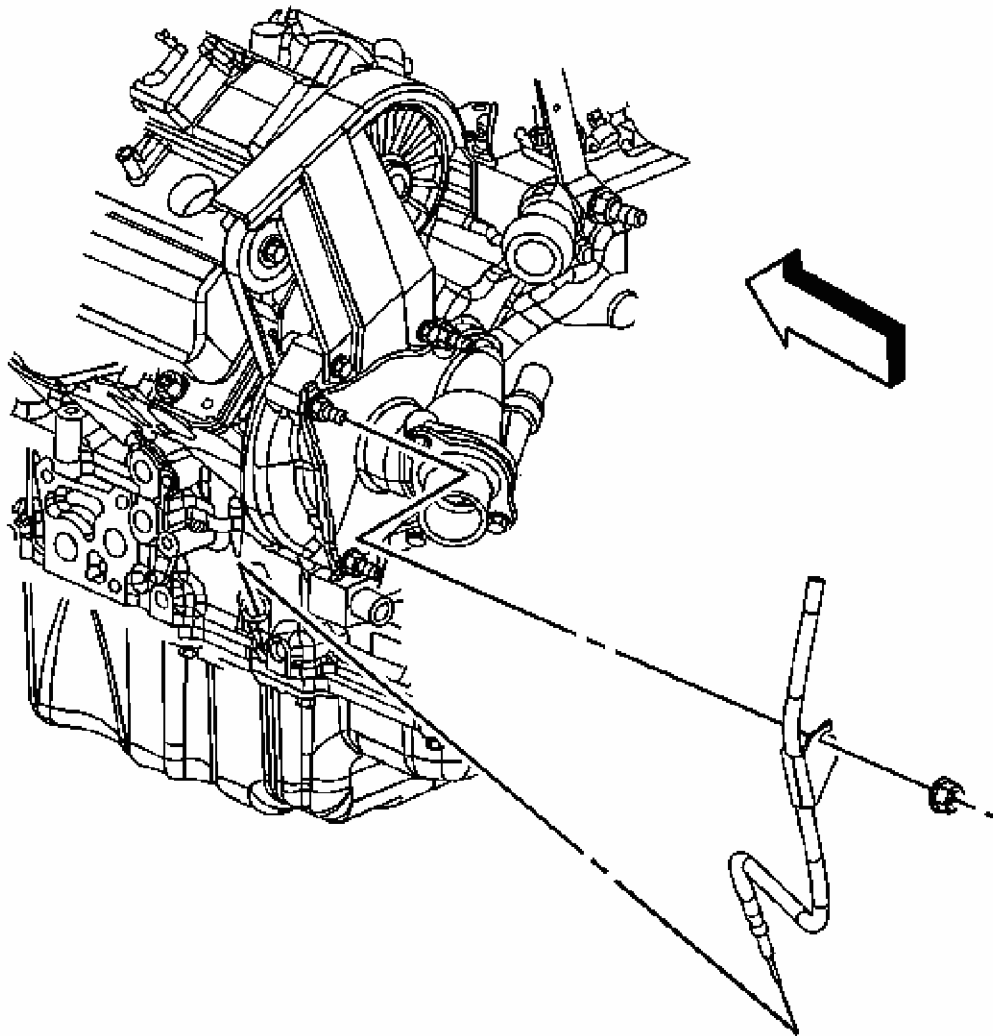


Fig. 84: Identifying Oil Level Indicator Tube
Courtesy of GENERAL MOTORS CORP.

1. Remove the front engine mount bracket. Refer to **Engine Front Mount Bracket Replacement**.
2. Remove the oil level indicator.
3. Loosen the oil level indicator tube nut.
4. Remove the oil level indicator tube.

INSTALLATION PROCEDURE

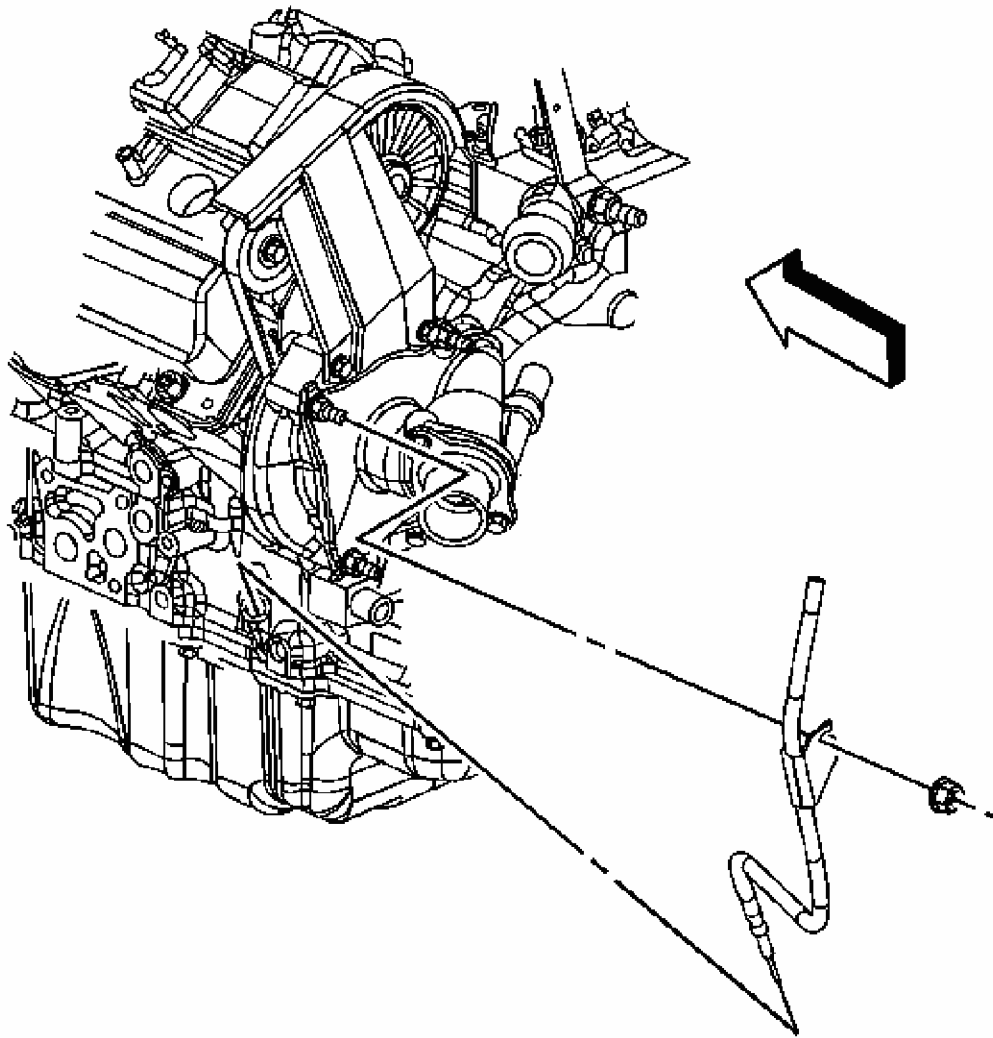


Fig. 85: Identifying Oil Level Indicator Tube
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the oil level indicator tube O-ring seal with clean engine oil.
2. Install the oil level indicator tube into the lower crankcase opening.

NOTE: Refer to Fastener Notice .

3. Slide the indicator tube behind the tube nut. Tighten the nut.

Tighten: Tighten the nut to 10 N.m (89 lb in).

4. Install the oil level indicator.
5. Install the front engine mount bracket. Refer to **Engine Front Mount Bracket Replacement**.

OIL FILTER ADAPTER REPLACEMENT

REMOVAL PROCEDURE

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the air deflector. Refer to **Front Air Deflector Replacement** .

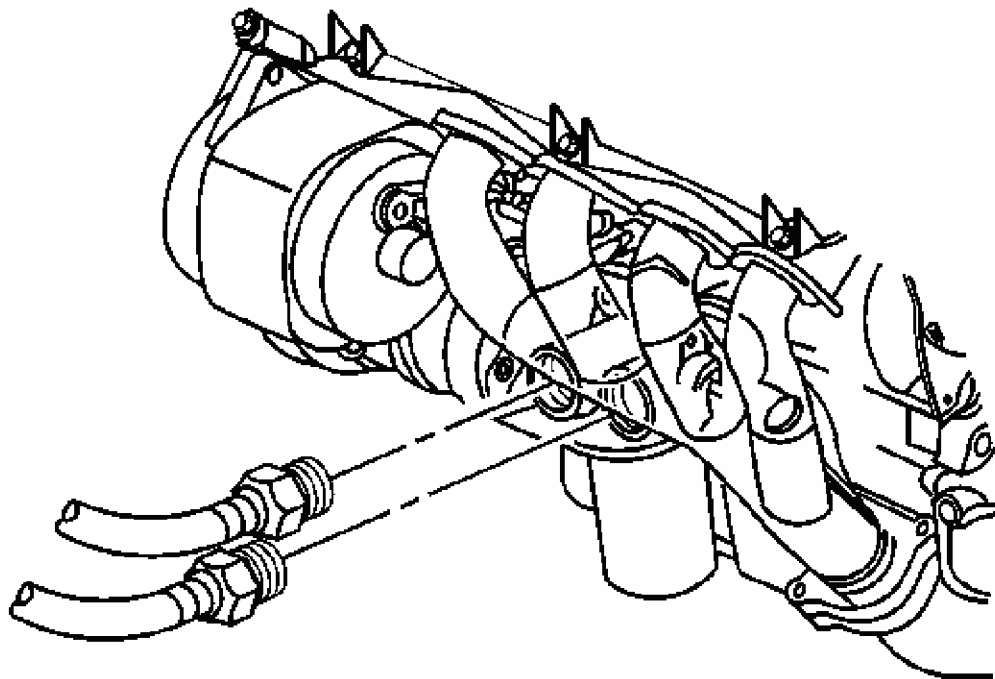


Fig. 86: View of Engine Oil Cooler Quick Connect Fittings
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Engine oil cooler quick connect fittings must be replaced whenever they are removed from the engine oil filter adapter.

3. If equipped, remove the engine oil cooler quick connect fittings from the engine oil filter adapter, with the oil pipes still attached.

If not equipped with an engine oil cooler, go to step 7.

4. Remove the dust cover from the quick connect joint.

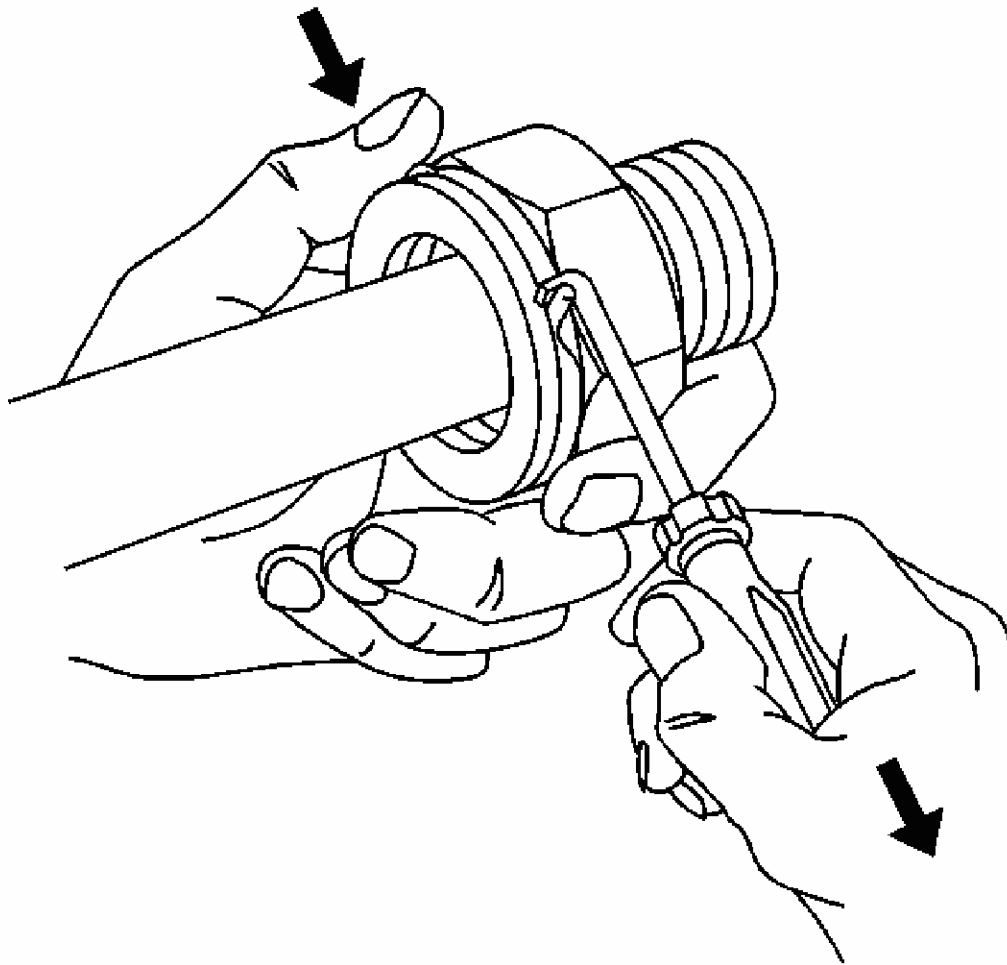


Fig. 87: Removing Internal Spring Clips
Courtesy of GENERAL MOTORS CORP.

5. Remove the internal spring clips from the engine oil cooler fittings.

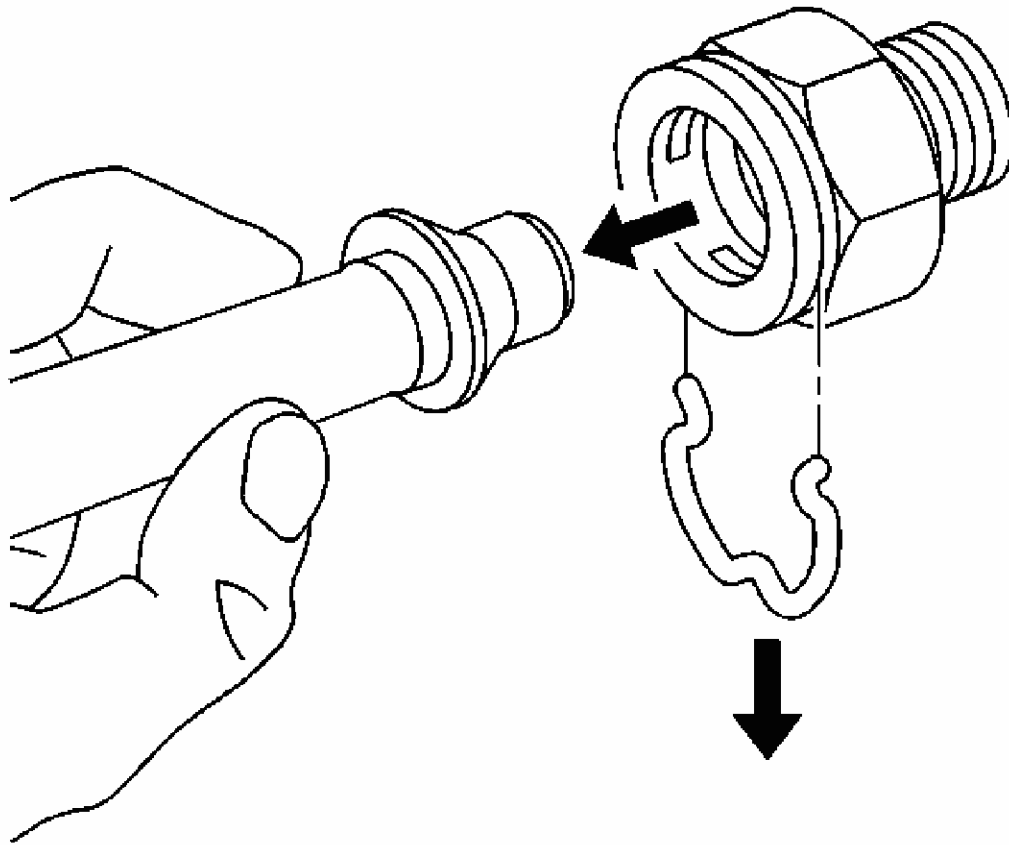


Fig. 88: View of Engine Cooler Pipes & Fittings
Courtesy of GENERAL MOTORS CORP.

6. Remove the engine oil cooler pipes from the cooler fittings.

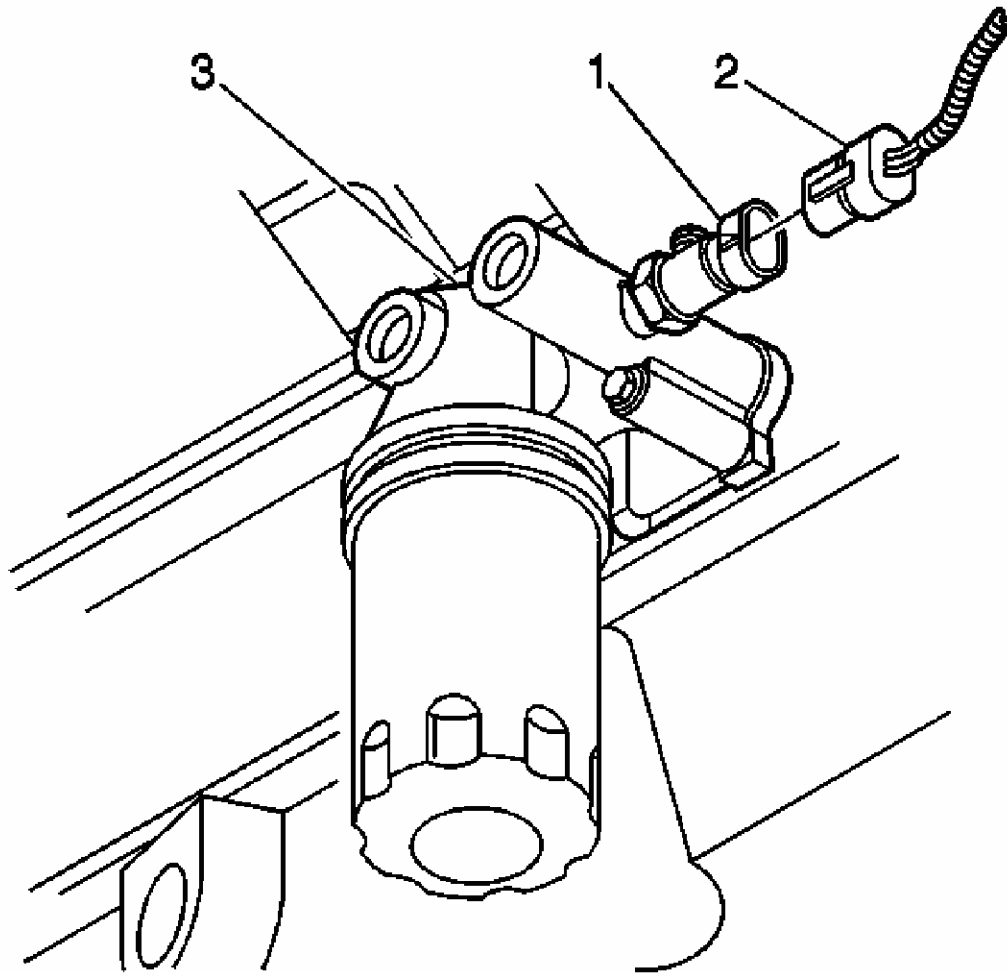


Fig. 89: View of Engine Oil Pressure Switch & Electrical Connector
Courtesy of GENERAL MOTORS CORP.

7. Disconnect the electrical connector (2) from the engine oil pressure switch (1).

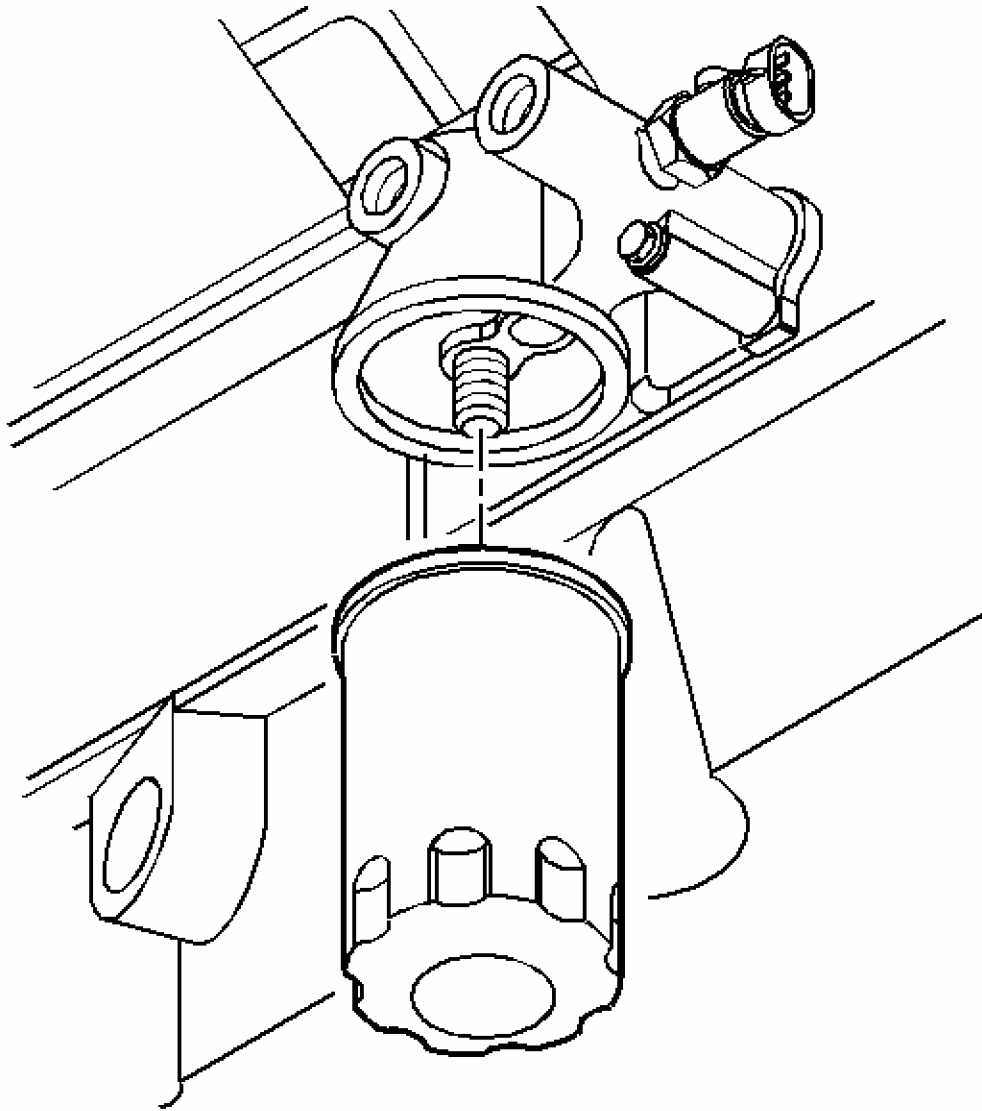


Fig. 90: Locating Oil Filter Adapter & Filter
Courtesy of GENERAL MOTORS CORP.

8. Remove the oil filter.

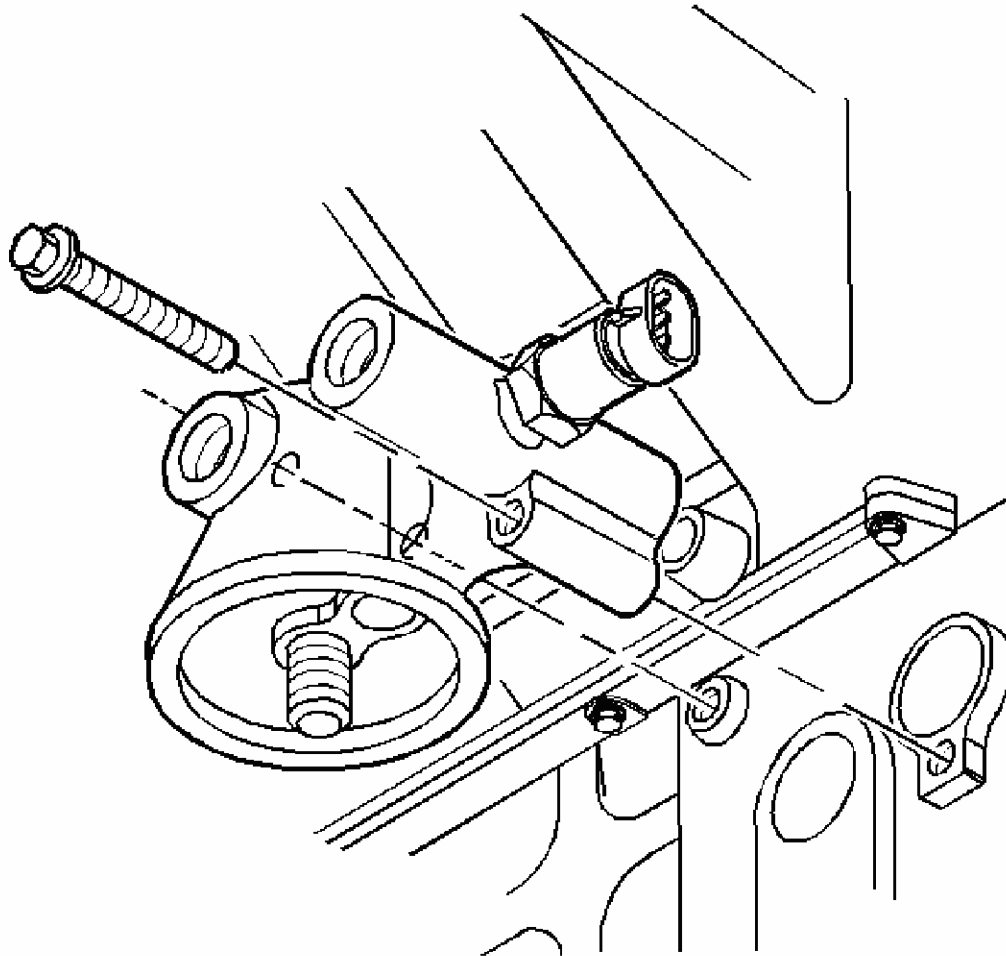


Fig. 91: Identifying Adapter Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

9. Remove the 2 adapter mounting bolts.
10. Remove the adapter and discard the O-rings.
11. Remove the engine oil pressure switch from the oil filter adapter.
12. Clean and inspect the oil filter adapter. Refer to **Oil Filter Adapter Cleaning and Inspection (without Oil Cooler)** or **Oil Filter Adapter Cleaning and Inspection (with Oil Cooler)** for the 4.6L, Unit Repair.

INSTALLATION PROCEDURE

NOTE: Refer to **Fastener Notice** .

1. Install the engine oil pressure switch to the oil filter adapter.

Tighten: Tighten the engine oil pressure switch to 16 N.m (12 lb ft).

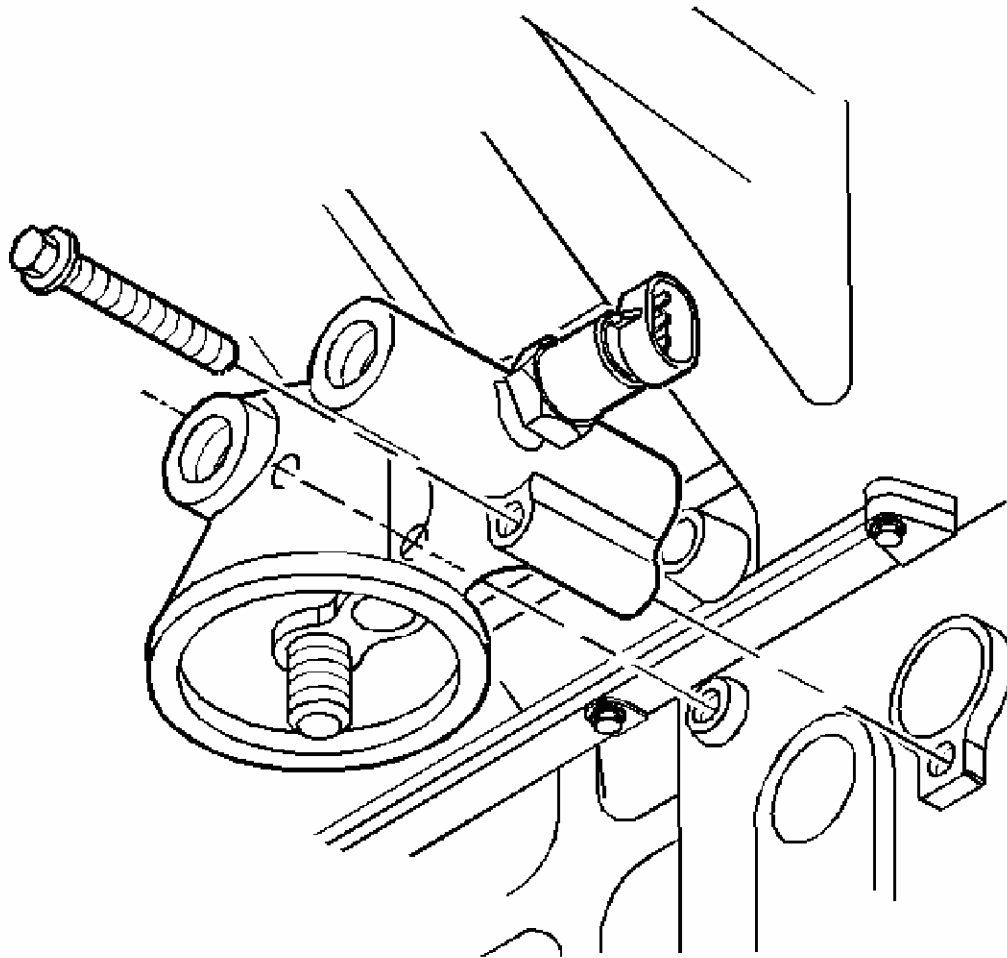


Fig. 92: Identifying Adapter Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

2. Install the new O-rings. Petrolatum may be used to retain the O-rings in the adapter.
3. Install the 2 bolts attaching the oil filter adapter to the engine block.

Tighten: Tighten the oil filter adapter bolts to 25 N.m (18 lb ft).

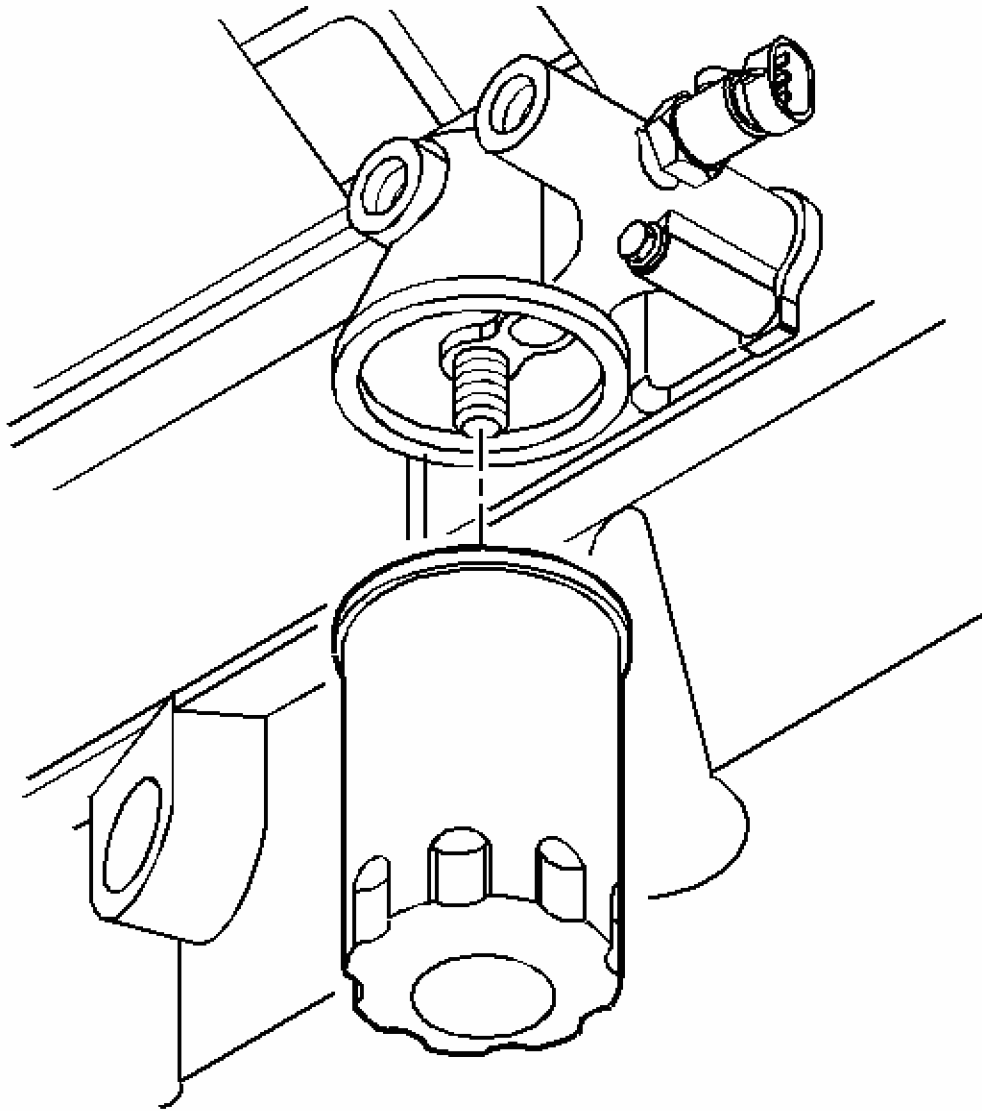


Fig. 93: Locating Oil Filter Adapter & Filter
Courtesy of GENERAL MOTORS CORP.

4. Lightly oil the replacement oil filter gasket with clean oil.

IMPORTANT: Fill the oil filter with the engine oil.

5. Install the oil filter.

Tighten: Tighten the oil filter to 32 N.m (24 lb ft).

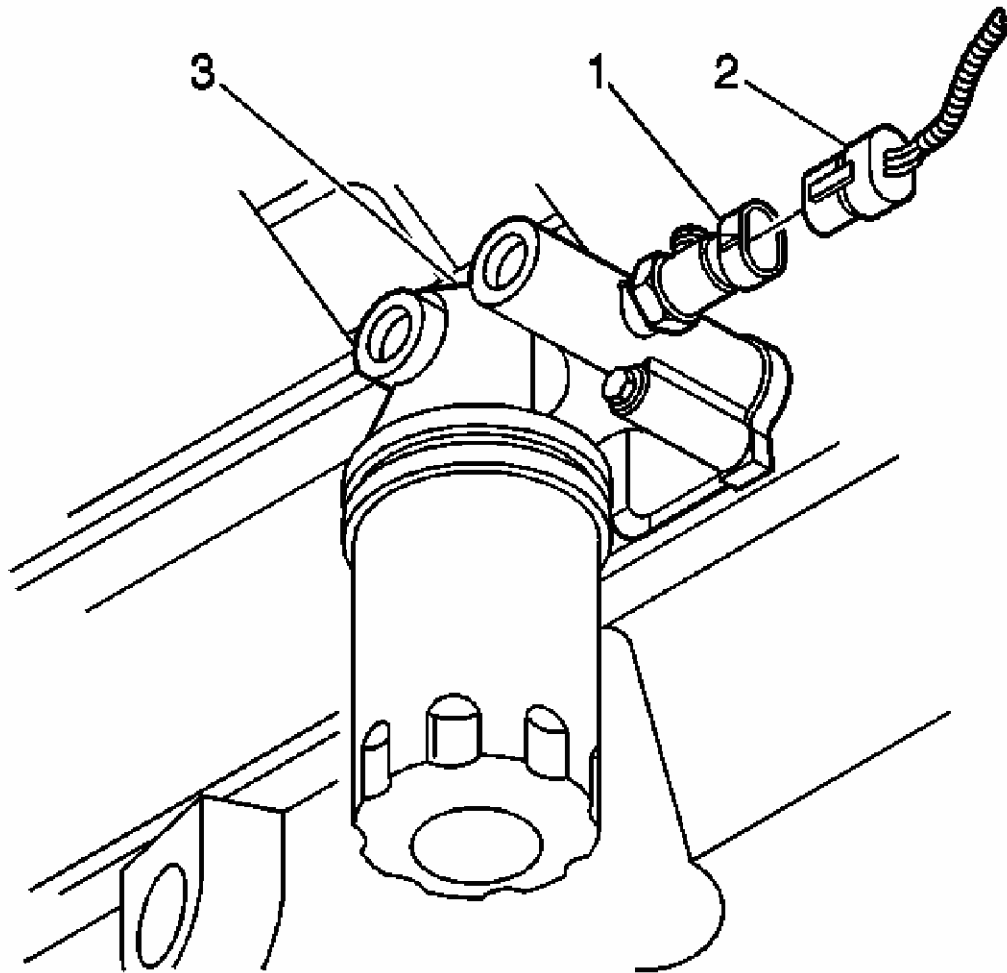


Fig. 94: View of Engine Oil Pressure Switch & Electrical Connector
Courtesy of GENERAL MOTORS CORP.

6. Connect the electrical connector (2) to the engine oil pressure switch (1).

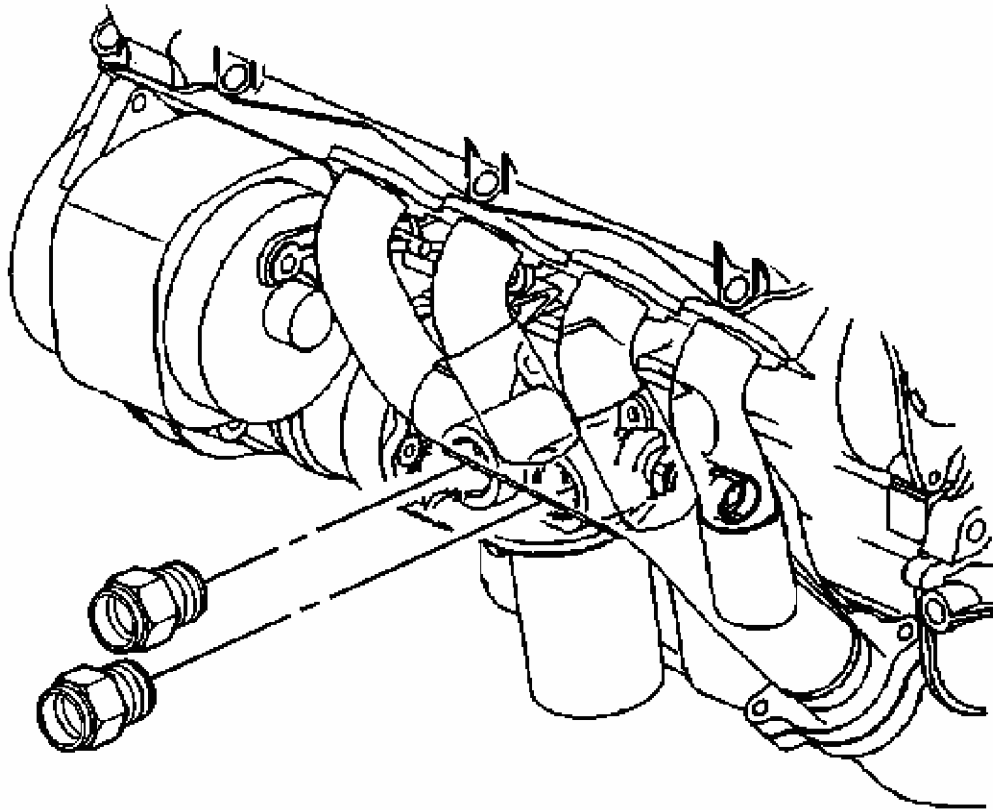


Fig. 95: View of Engine Oil Cooler Quick Connect Fittings
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Engine oil cooler quick connect fittings must be replaced whenever they are removed from the engine oil filter adapter.

7. If equipped, install the engine oil cooler quick connect fittings to the engine oil filter adapter.

If not equipped with an engine oil cooler, proceed to step 1.

Tighten: Tighten the engine oil cooler quick connect fittings to 18 N.m (13 lb ft).

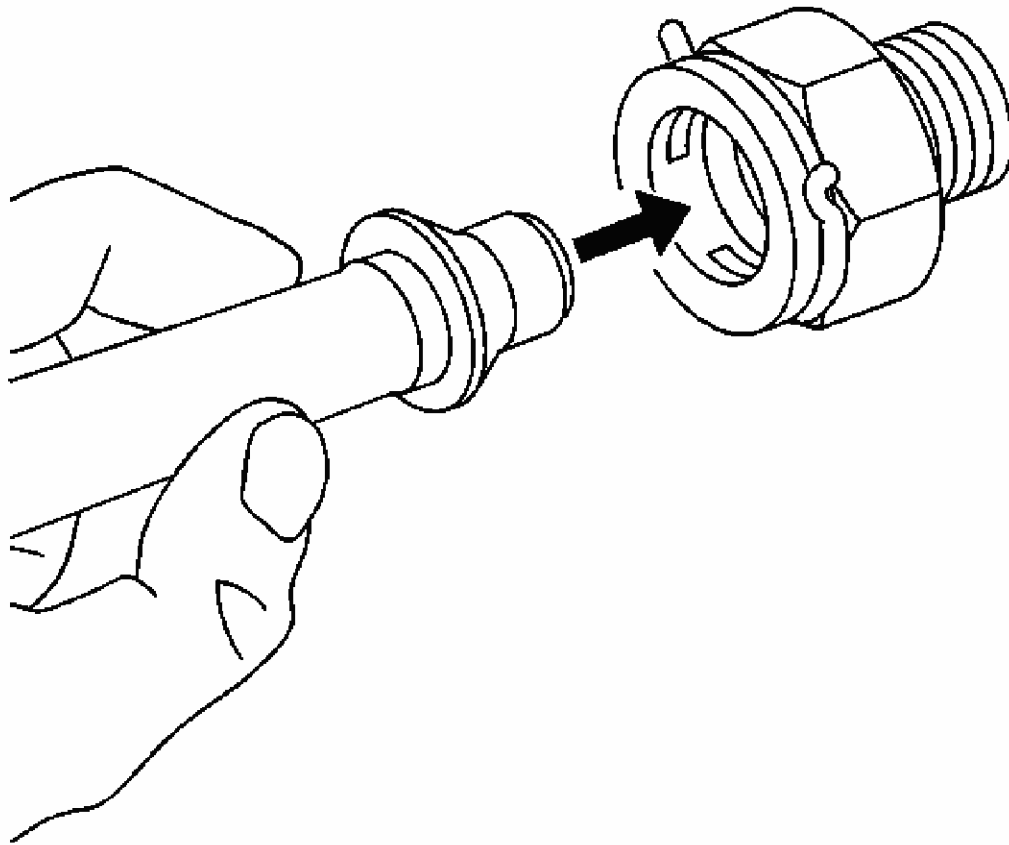


Fig. 96: View of Engine Oil Cooler Pipes & Oil Cooler Quick Connect Fittings
Courtesy of GENERAL MOTORS CORP.

8. Push the engine oil cooler pipes fully into the oil cooler quick connect fittings, until a "click" is heard.
9. Tug gently on the cooler pipes to ensure proper retention.
10. Slide the dust cover over the quick connect joint.
11. Install the air deflector. Refer to **Front Air Deflector Replacement** .
12. Lower the vehicle.
13. Adjust the engine oil level to the full mark.
14. Inspect for oil leaks after engine start up.

CRANKSHAFT BALANCER REPLACEMENT

TOOLS REQUIRED

- **J 45059** Angle Meter
- **J 41816** Crankshaft Balancer Remover. See **Special Tools** .
- **J 41998-B** Crankshaft Balancer Installer. See **Special Tools** .
- **J 44214** Flywheel Holder. See **Special Tools** .

REMOVAL PROCEDURE

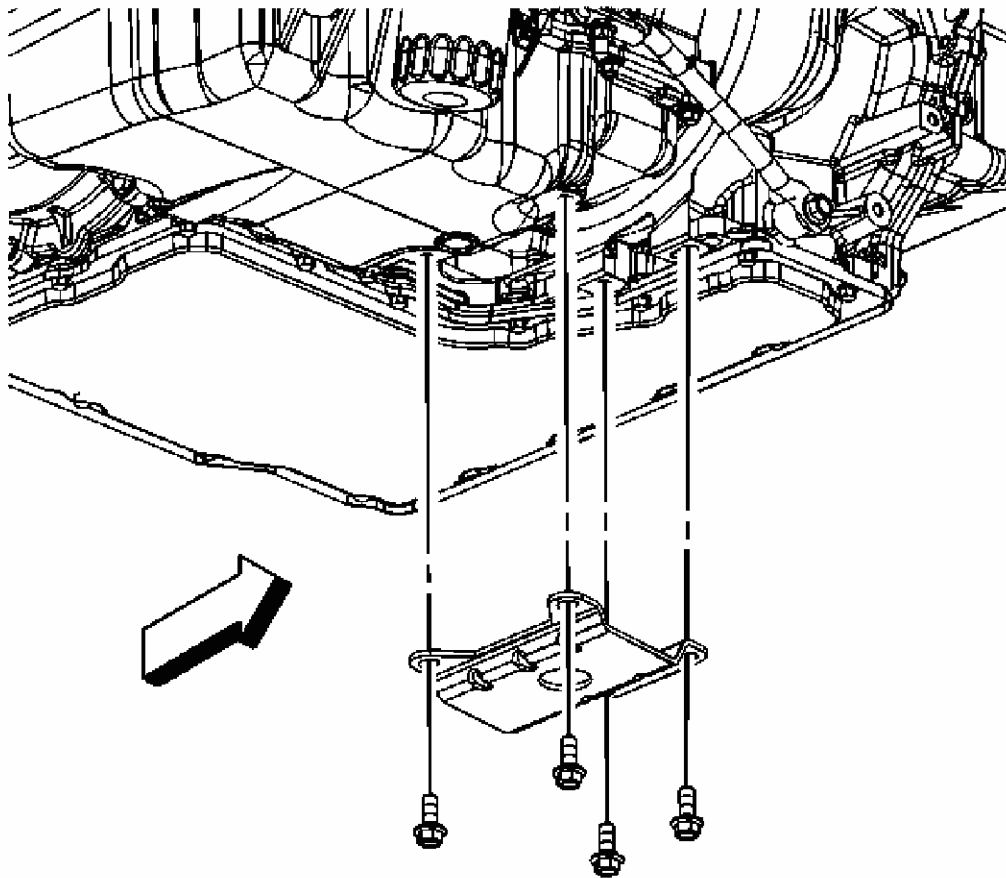


Fig. 97: Identifying Transaxle To Engine Brace Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the drive belt. Refer to **Drive Belt Replacement**.
2. Remove the transaxle to engine brace bolts.
3. Remove the transaxle to engine brace.

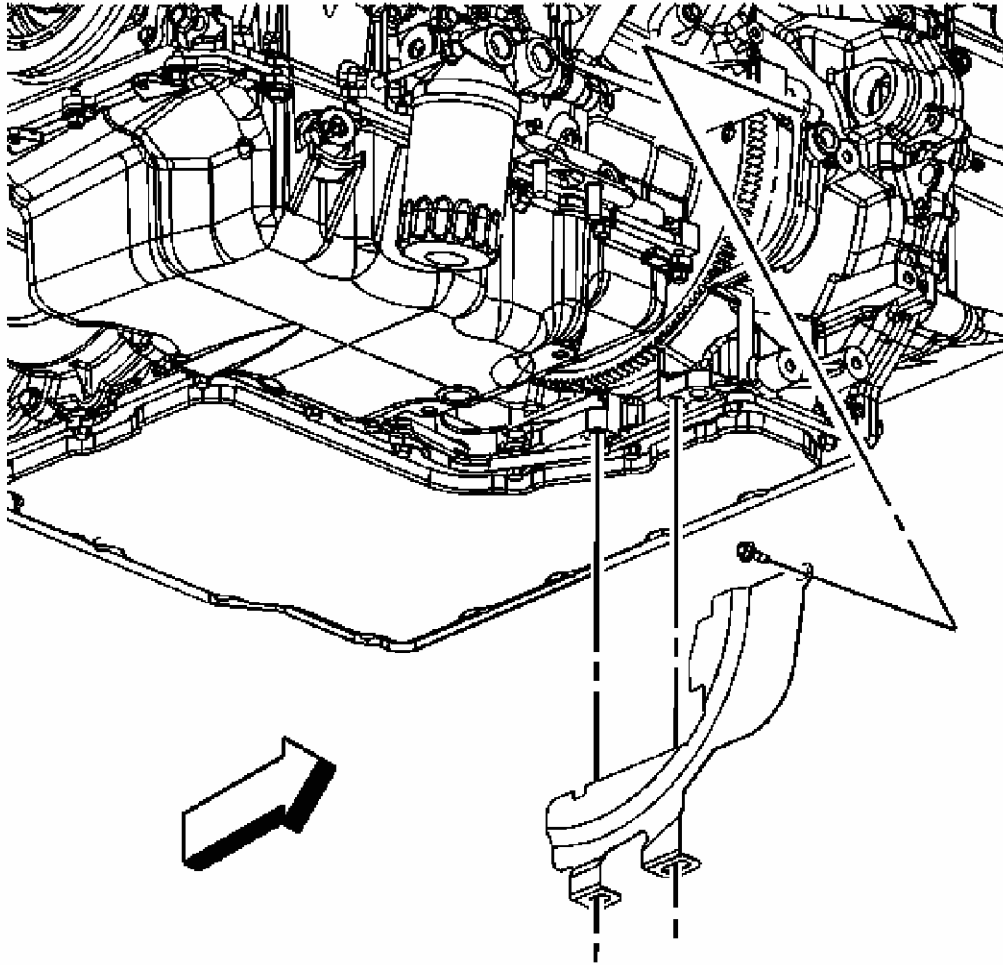


Fig. 98: View Of Torque Converter Cover
Courtesy of GENERAL MOTORS CORP.

4. Remove the torque converter cover bolt.
5. Remove the torque converter cover.

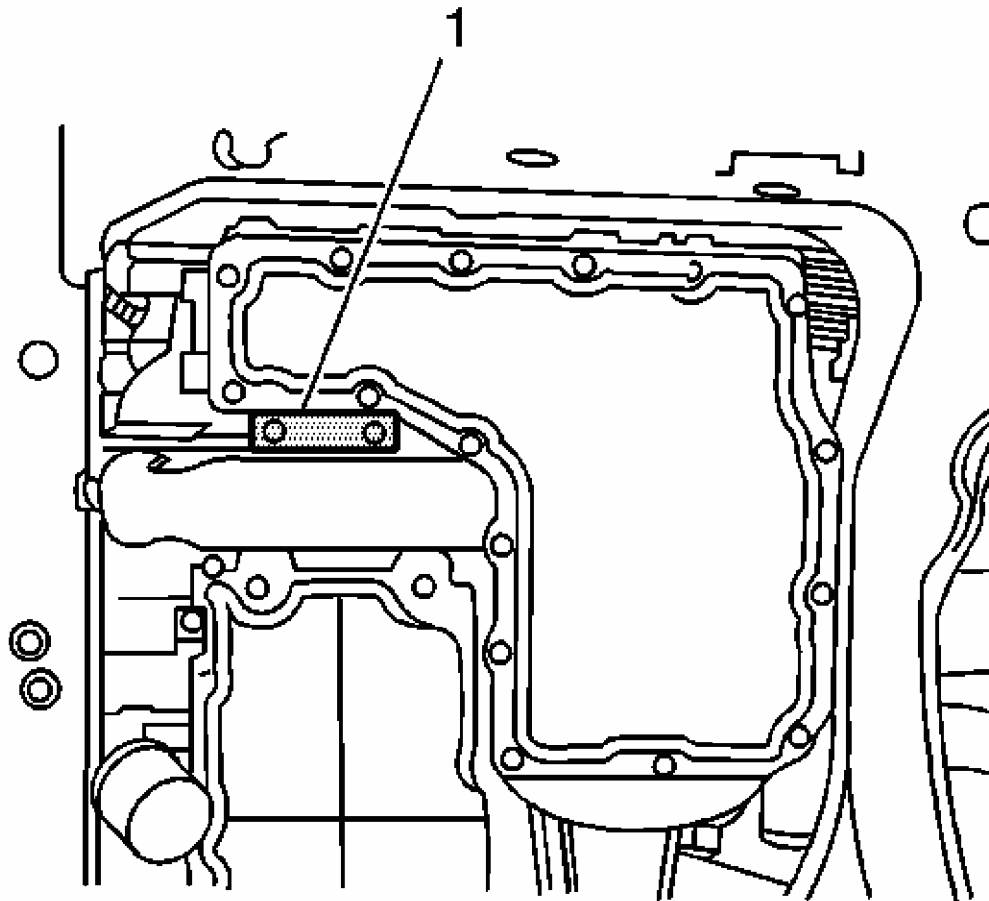


Fig. 99: Locating Flywheel Holder J 44214
Courtesy of GENERAL MOTORS CORP.

6. Install the **J 44214** (1). See **Special Tools** .
7. Remove the crankshaft balancer bolt.
8. Remove the front fascia. Refer to **Front Bumper Fascia Replacement** .
9. Support the frame with a suitable adjustable jack.
10. Loosen the right side frame bolts.
11. Lower the frame in order to obtain clearance for the **J 41816** below the body rail. See **Special Tools** .

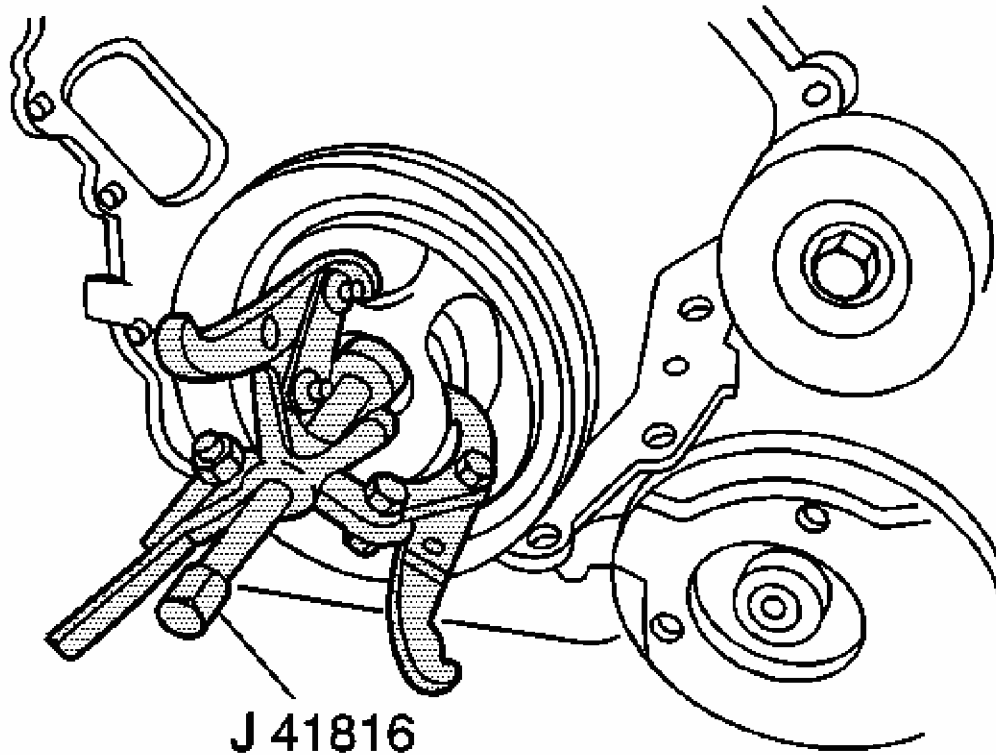


Fig. 100: View of J 41816 Removing Crankshaft Balancer
Courtesy of GENERAL MOTORS CORP.

12. Place the remover pilot into the end of the crankshaft.
13. Remove the crankshaft balancer using the **J 41816** . See **Special Tools** .

INSTALLATION PROCEDURE

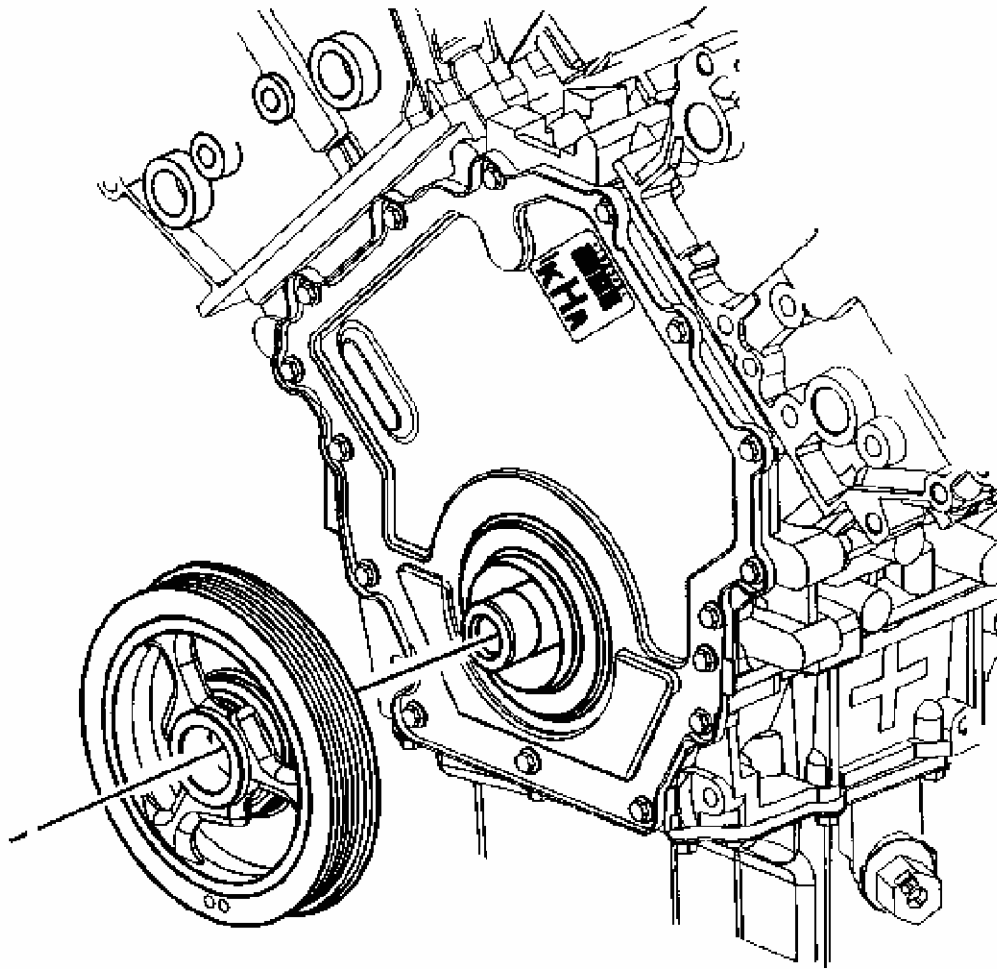


Fig. 101: View of Crankshaft Balancer
Courtesy of GENERAL MOTORS CORP.

1. Position the crankshaft balancer on the nose of the crankshaft.

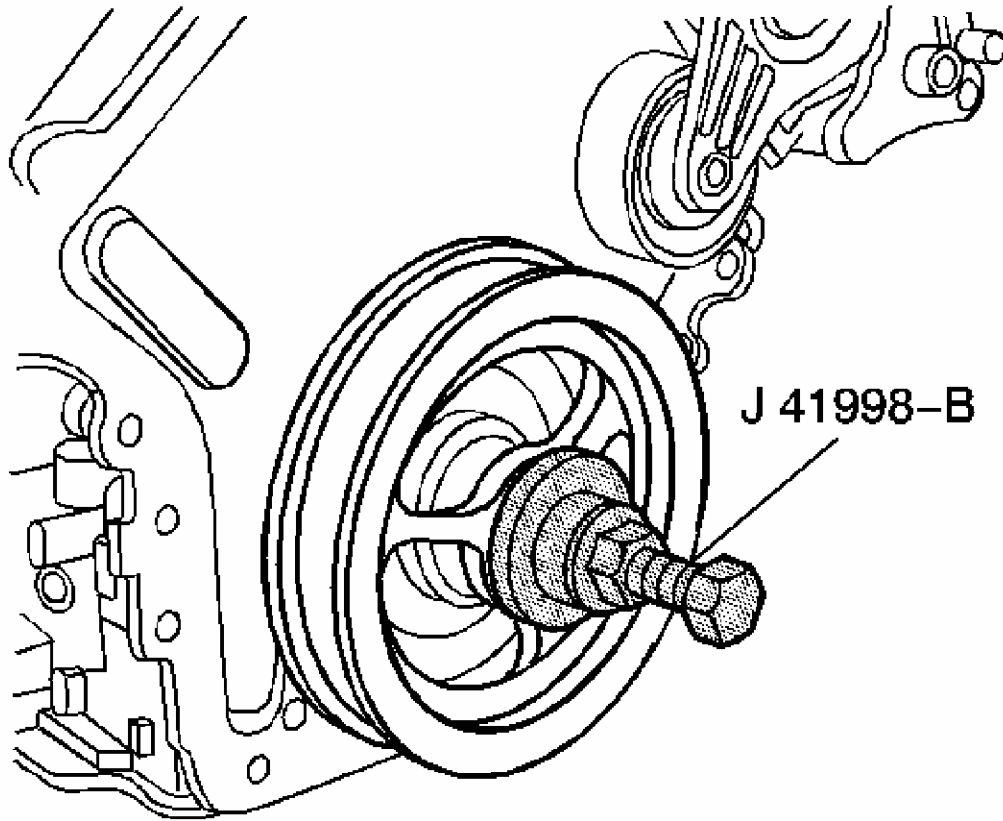


Fig. 102: Identifying J 41998-A Installing Crankshaft Balancer
Courtesy of GENERAL MOTORS CORP.

2. Press the crankshaft balancer in place using the **J 41998-B** . See **Special Tools** .

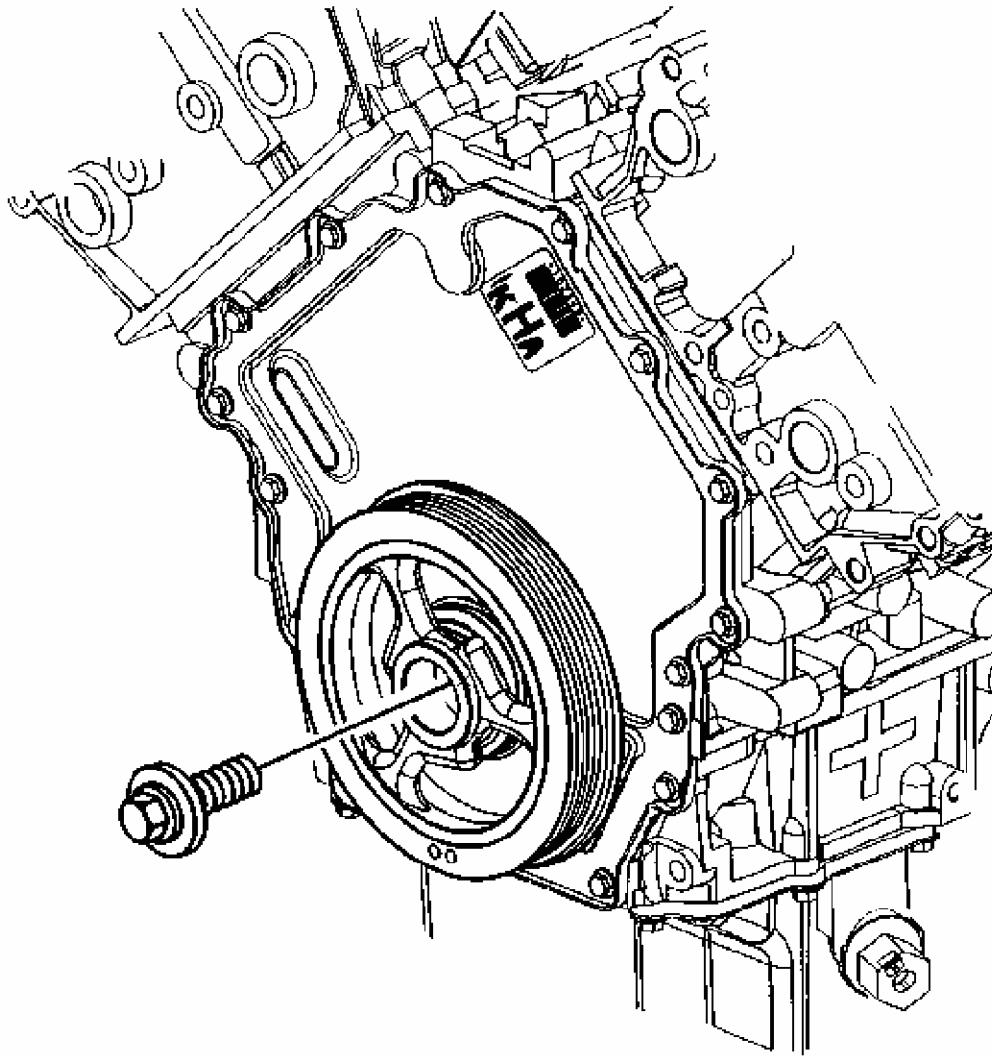


Fig. 103: View of Crankshaft Balancer Bolt Threads
Courtesy of GENERAL MOTORS CORP.

3. Clean the crankshaft balancer bolt threads.
4. Apply engine oil to the crankshaft balancer bolt threads.

NOTE: Refer to Fastener Notice .

5. Install the crankshaft balancer bolt.

Tighten:

- Tighten the bolt a first pass to 50 N.m (37 lb ft).
- Tighten the bolt a final pass an additional 120 degrees using the **J 45059** .

6. Raise the frame into position.
7. Install the right side frame bolts.

Tighten: Tighten the bolts to 181 N.m (133 lb ft).

8. Install the front fascia. Refer to **Front Bumper Fascia Replacement** .
9. Remove the support(s) from the frame.

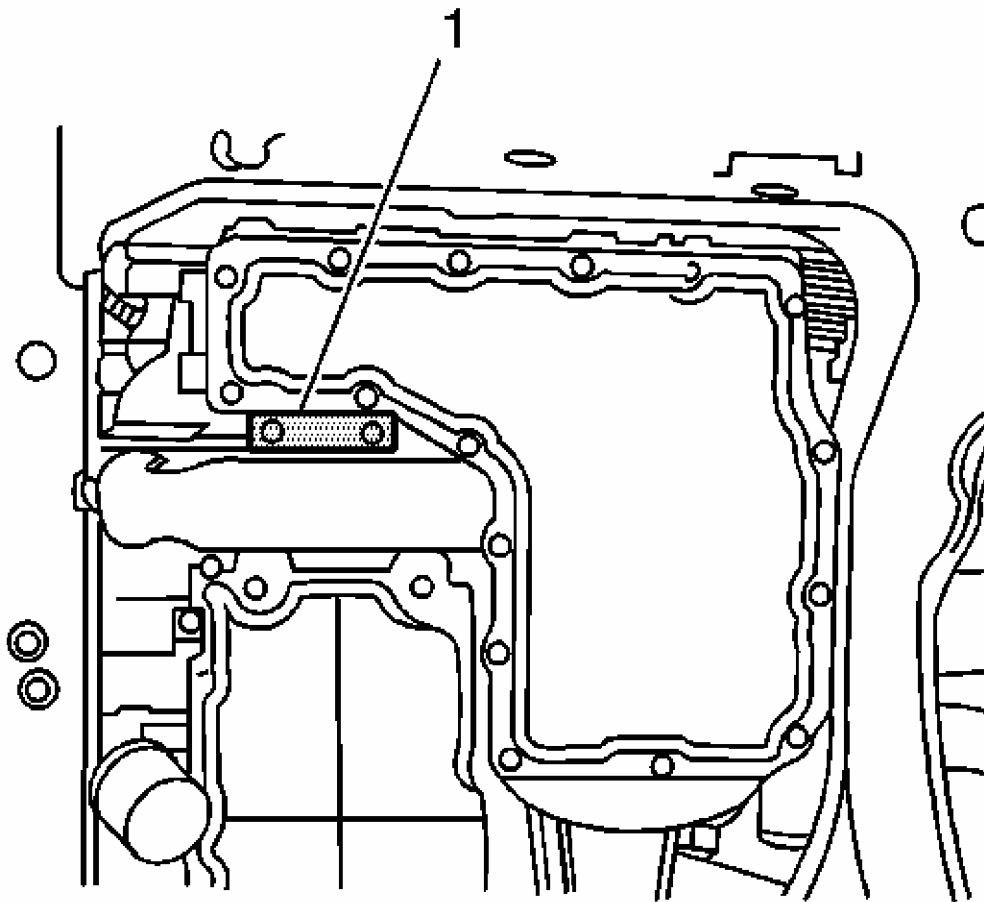


Fig. 104: Locating Flywheel Holder J 44214
Courtesy of GENERAL MOTORS CORP.

10. Remove the **J 44214** (1). See **Special Tools** .

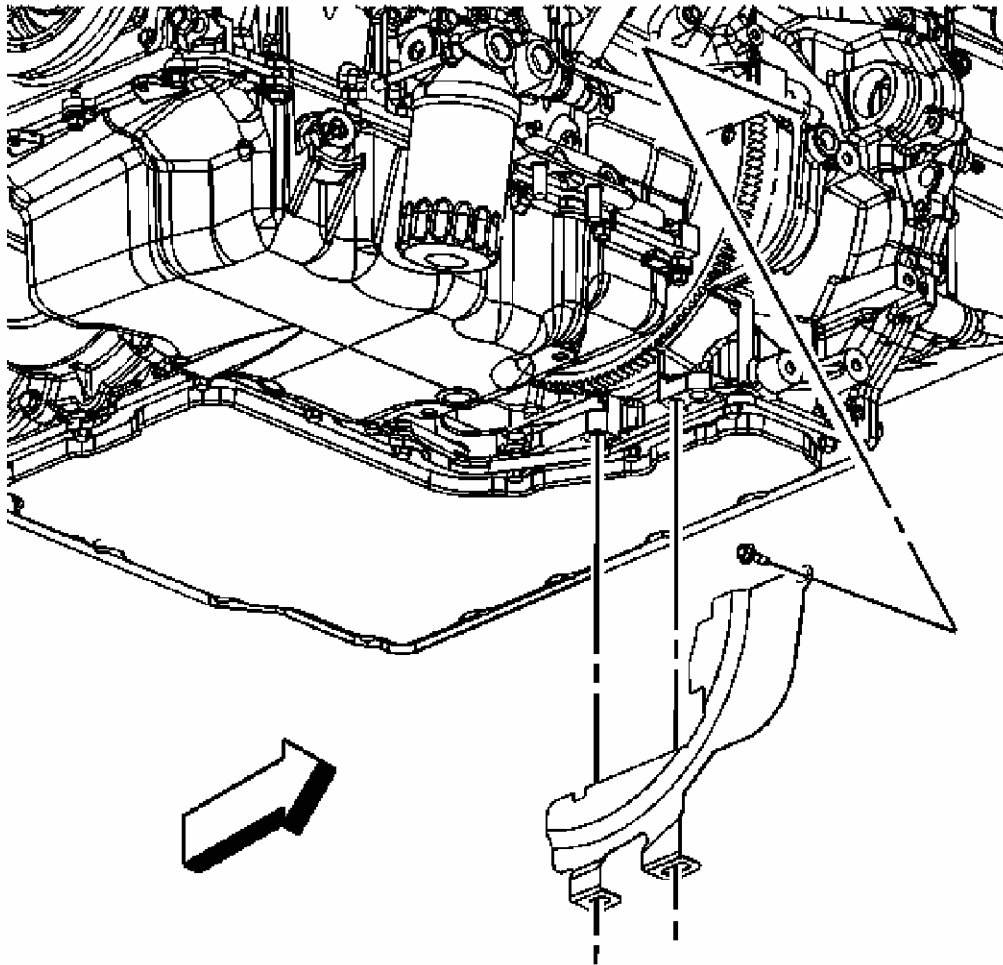


Fig. 105: View Of Torque Converter Cover
Courtesy of GENERAL MOTORS CORP.

11. Position the torque converter cover.
12. Install the torque converter cover bolt.

Tighten: Tighten the bolt to 12 N.m (106 lb in).

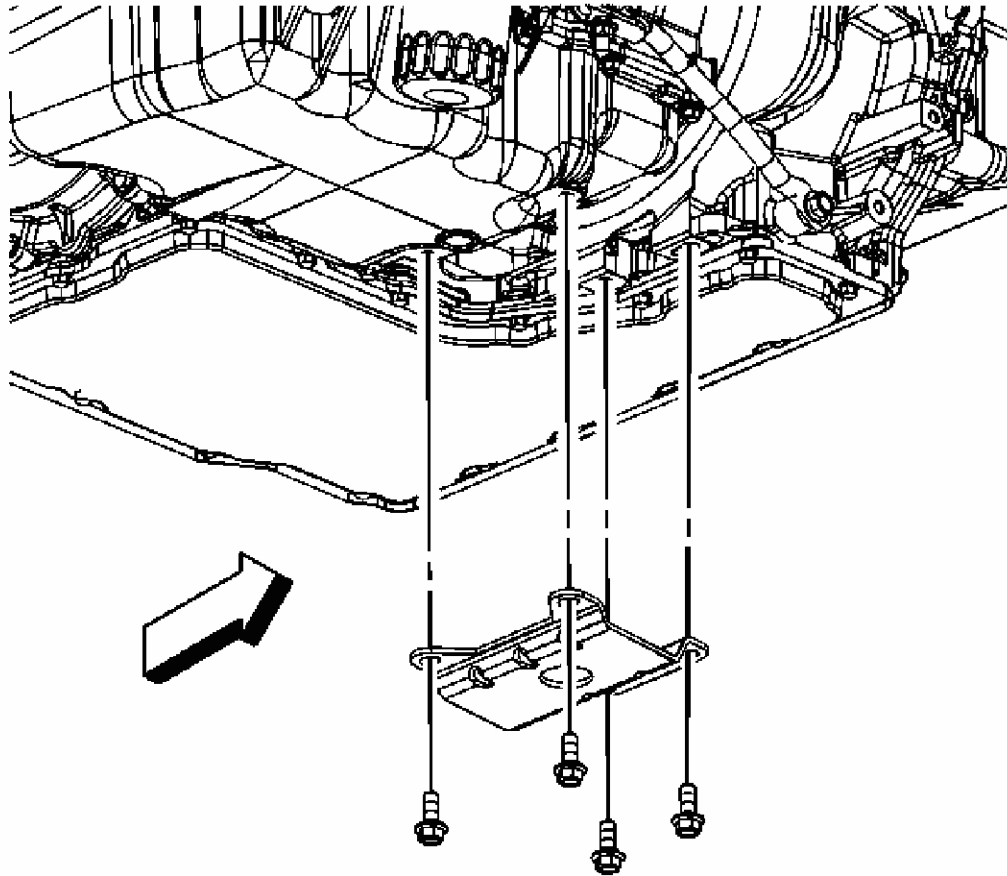


Fig. 106: Identifying Transaxle To Engine Brace Bolts
Courtesy of GENERAL MOTORS CORP.

13. Install the transaxle to engine brace.
14. Install the transaxle to engine brace bolts.

Tighten: Tighten the bolts to 47 N.m (35 lb ft).

15. Install the drive belt. Refer to **Drive Belt Replacement**.

ENGINE FRONT COVER REPLACEMENT

REMOVAL PROCEDURE

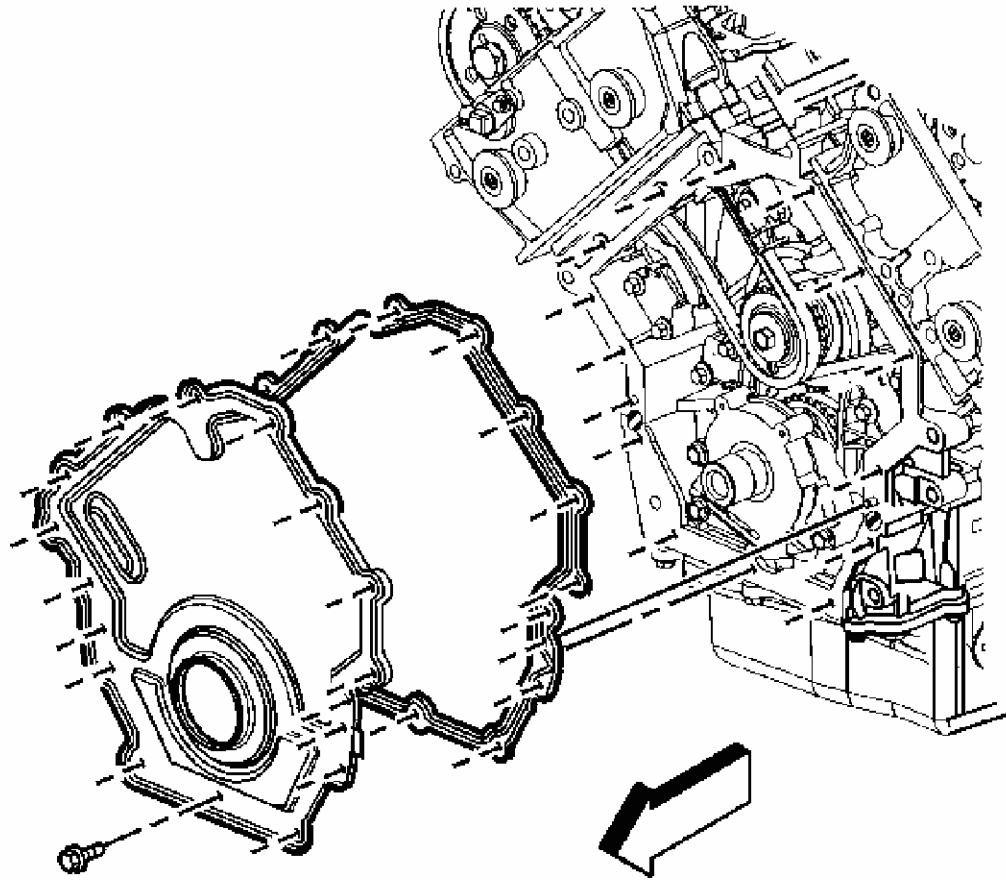


Fig. 107: View of Engine Front Cover Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the drive belt idler pulley. Refer to **Drive Belt Idler Pulley Replacement**.
2. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
3. Remove the engine front cover bolts.
4. Remove the engine front cover and gasket. The gasket is reusable. Do not discard unless it is damaged.

INSTALLATION PROCEDURE

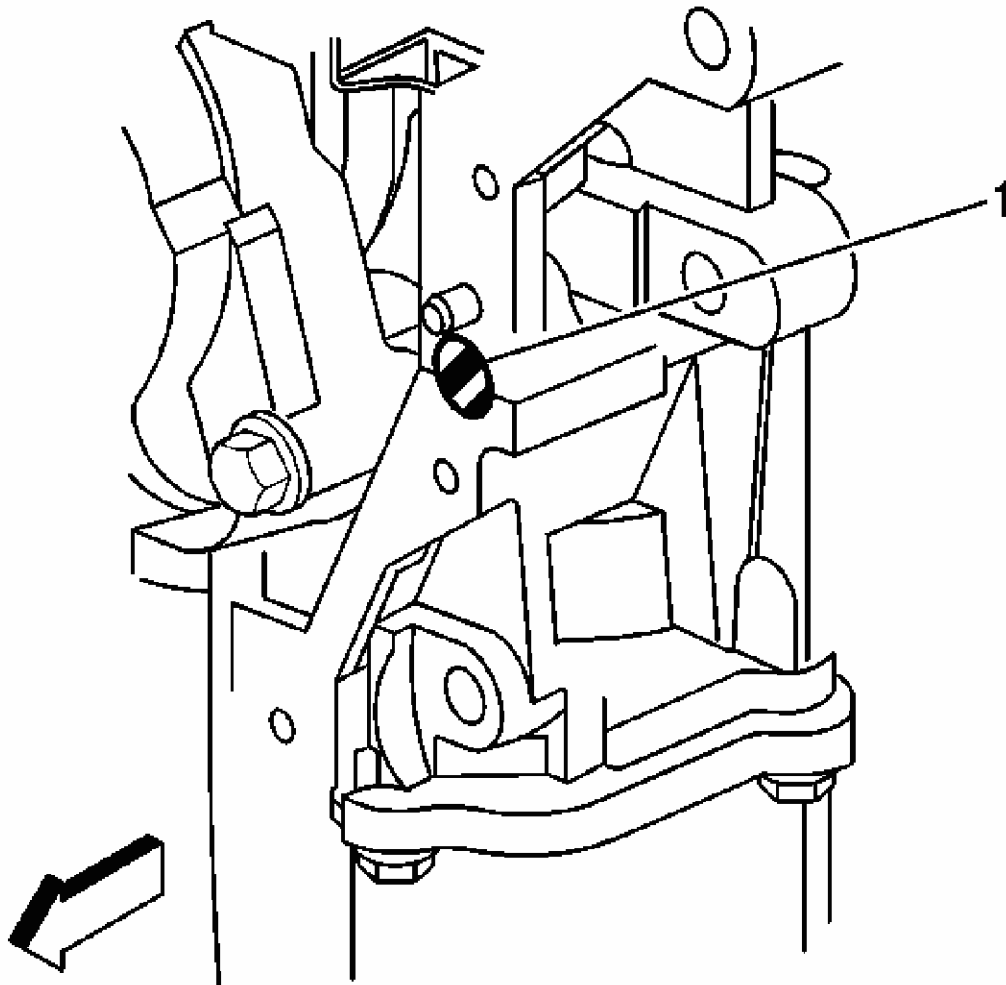


Fig. 108: Identifying Split Line of the Upper & Lower Crankcases
Courtesy of GENERAL MOTORS CORP.

1. Place a small amount of sealant at the split line of the upper and lower crankcases (1). Refer to **Sealers, Adhesives and Lubricants** for the correct part number.

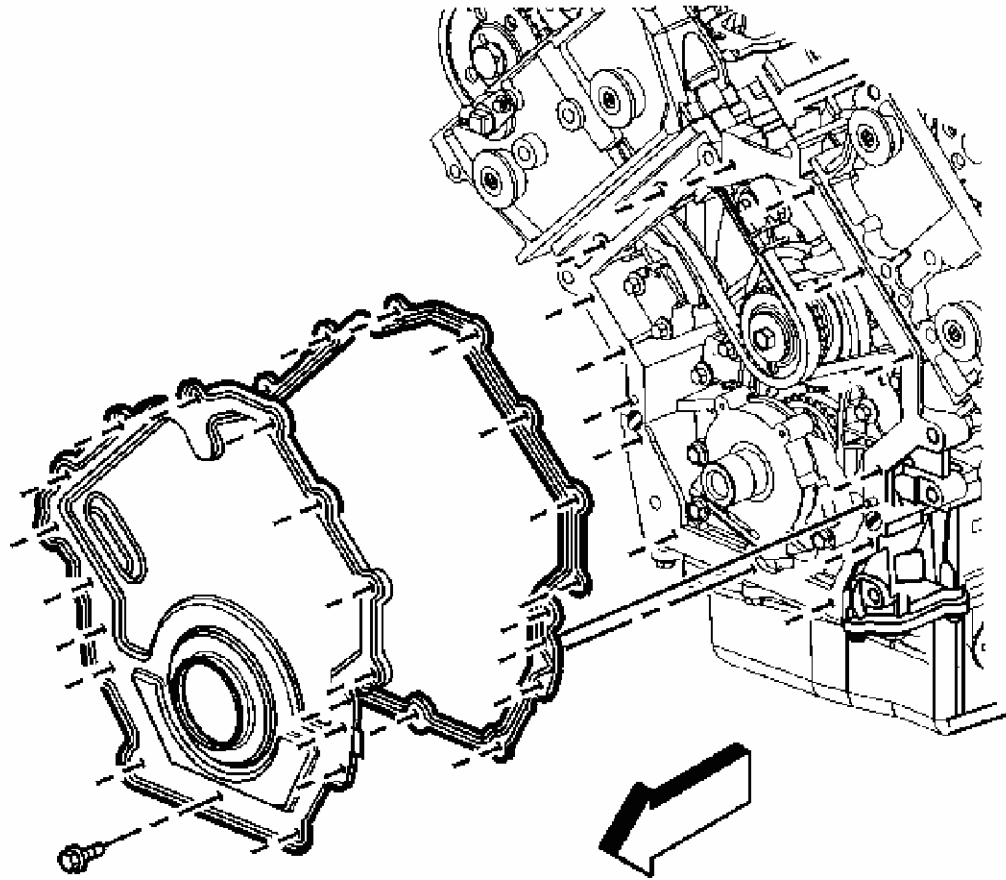


Fig. 109: View of Engine Front Cover Bolts

Courtesy of GENERAL MOTORS CORP.

2. Place the engine front cover gasket over the crankcase dowel pins.
3. Place the engine front cover in position on the crankcase.
4. Apply threadlock to the engine front cover bolts. Refer to **Sealers, Adhesives and Lubricants** for the correct part number.
5. Install the engine front cover bolts until snug.

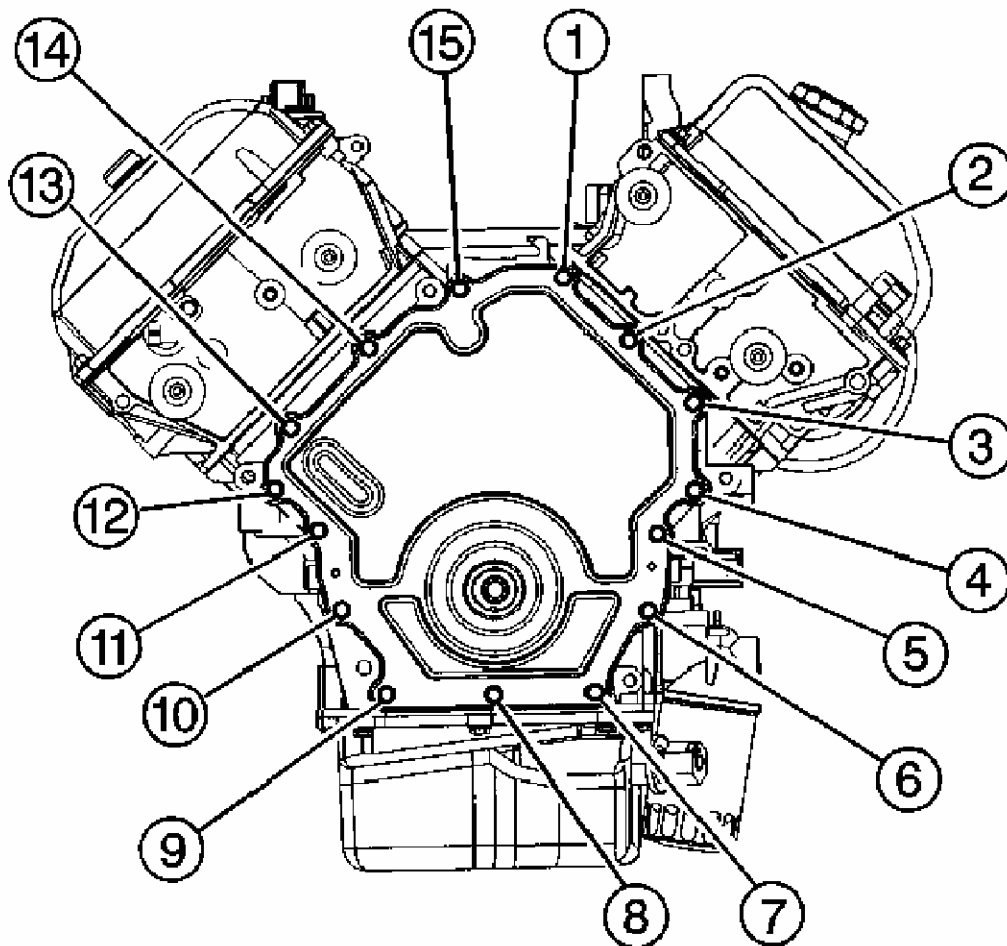


Fig. 110: Identifying Engine Front Cover Bolts
 Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

6. Tighten the engine front cover bolts.

Tighten: Tighten the bolts in the sequence to 10 N.m (89 lb in).

7. Install the crankshaft balancer. Refer to Crankshaft Balancer Replacement.
8. Install the drive belt idler pulley. Refer to Drive Belt Idler Pulley Replacement.

OIL PUMP REPLACEMENT

TOOLS REQUIRED

J 45059 Angle Meter**REMOVAL PROCEDURE**

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.

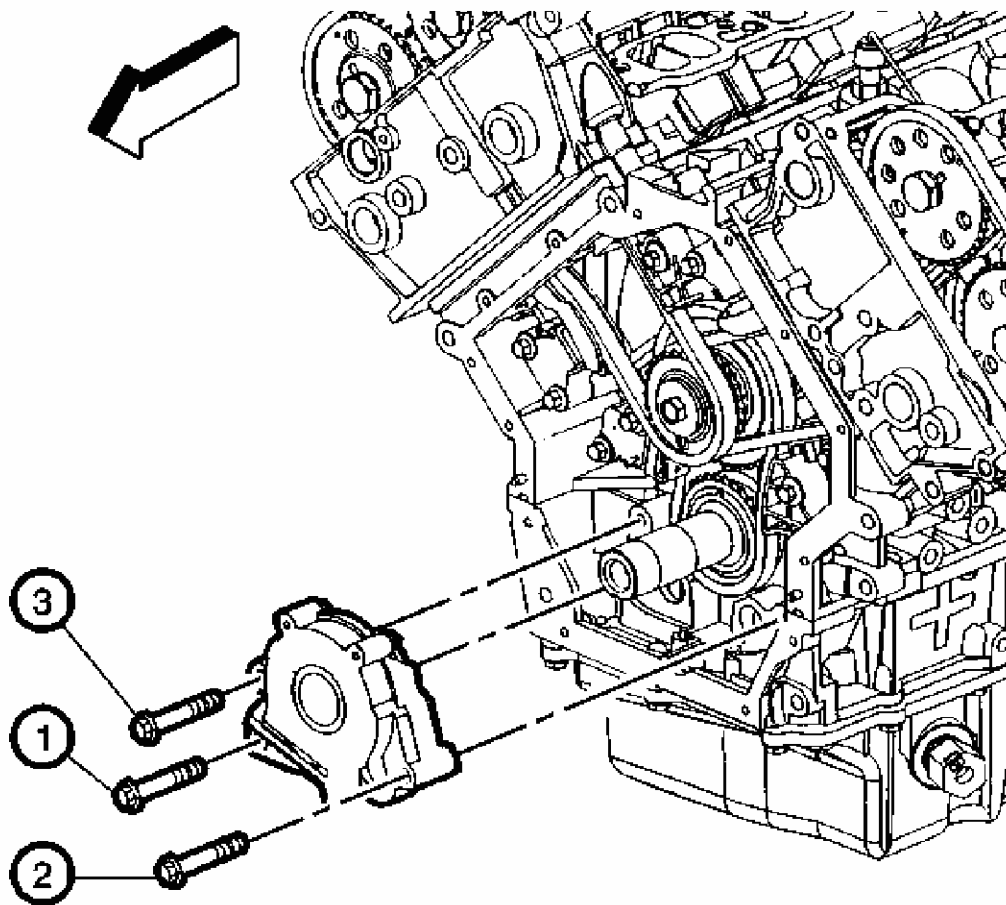


Fig. 111: Identifying Oil Pump Assembly Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

2. Remove the 3 oil pump assembly retaining bolts (1, 2, 3) identified by the larger head size.
3. Slide the oil pump assembly off the nose of the crankshaft with the drive collar in place.
4. Clean and inspect the oil pump. Refer to **Oil Pump Cleaning and Inspection**.

INSTALLATION PROCEDURE

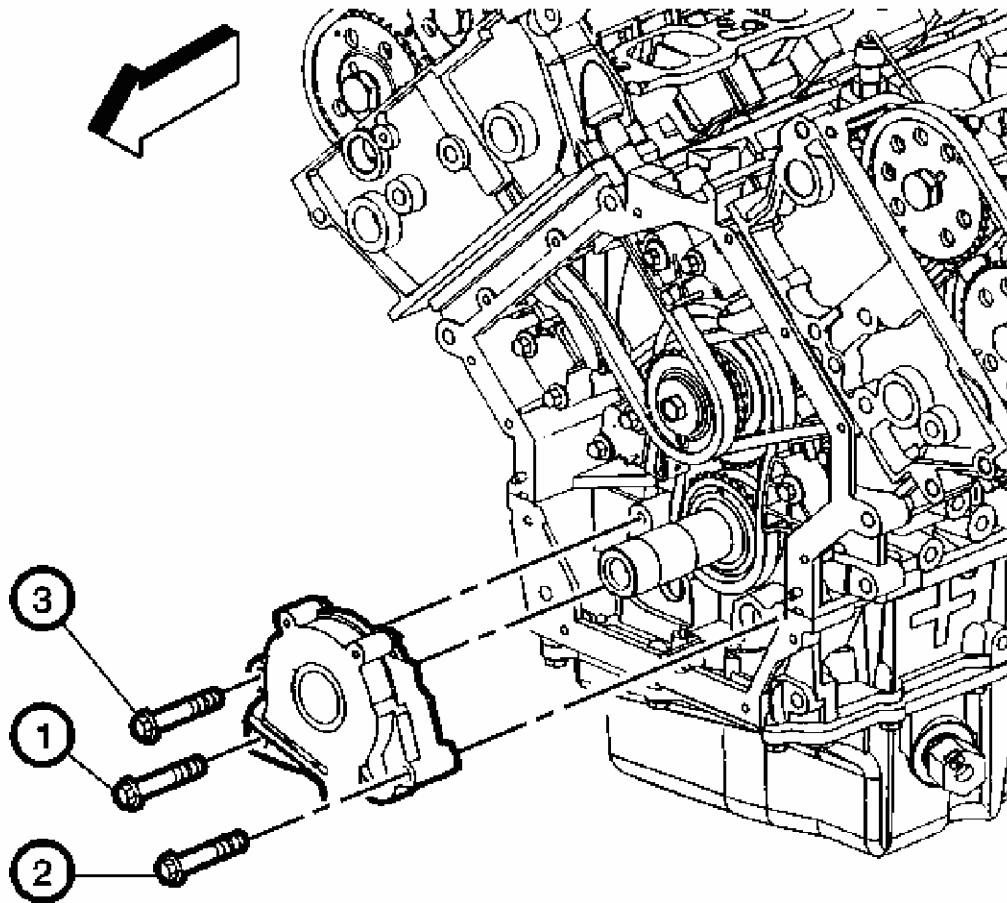


Fig. 112: Identifying Oil Pump Assembly Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the oil pump drive spacer into the oil pump so that the drive flat engages the pump rotor.
2. Position the oil pump on the crankshaft.
3. Install the retaining bolts.

NOTE: Refer to FASTENER NOTICE .

4. Apply upward pressure on the pump while tightening the three retaining bolts. Tighten the bolts in the sequence (1, 2, 3) shown.

Tighten:

- First Pass

Tighten the oil pump mounting bolts in sequence to 10 N.m (89 lb in).

- Final Pass

Tighten the oil pump mounting bolts in sequence an additional 35 degrees using the **J 45059** .

5. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

ENGINE OIL PRESSURE SENSOR AND/OR SWITCH REPLACEMENT

REMOVAL PROCEDURE

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

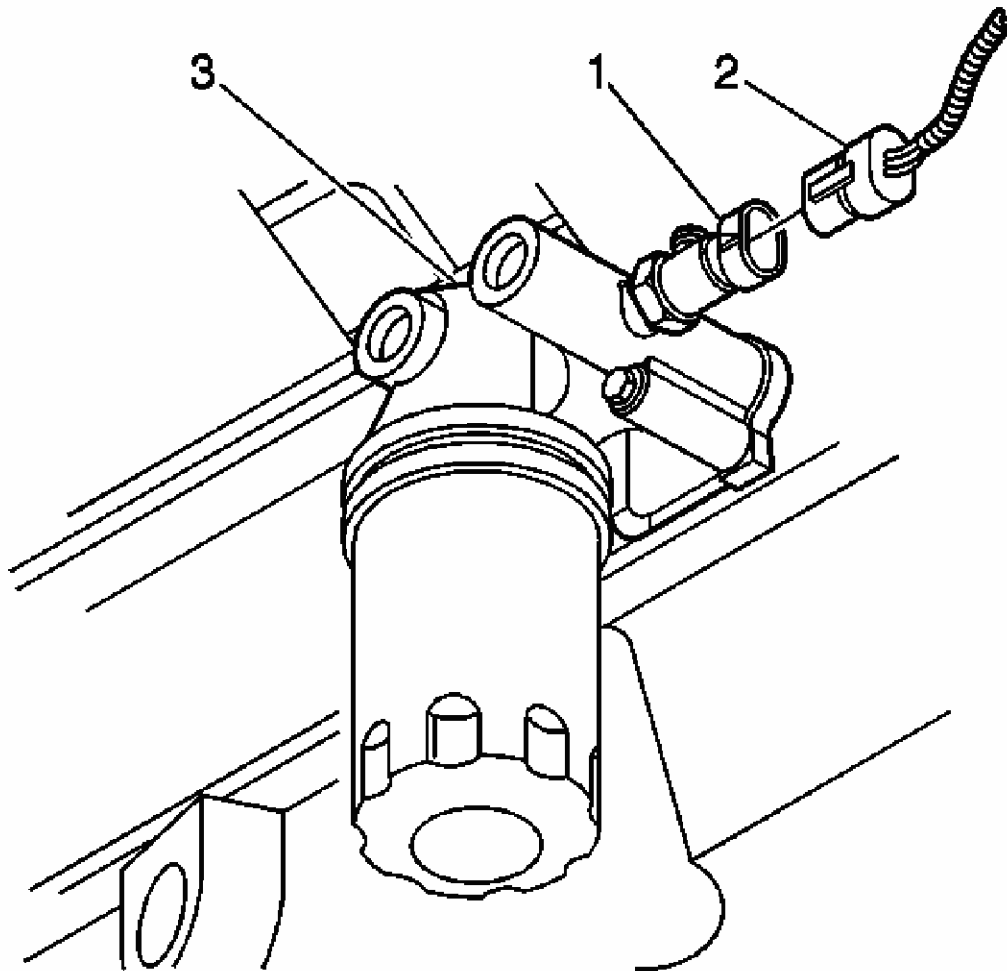


Fig. 113: View of Engine Oil Pressure Switch & Electrical Connector
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the electrical connector (2) from the engine oil pressure switch (1).
3. Remove the engine oil pressure switch (1) from the oil filter adapter (3).

INSTALLATION PROCEDURE

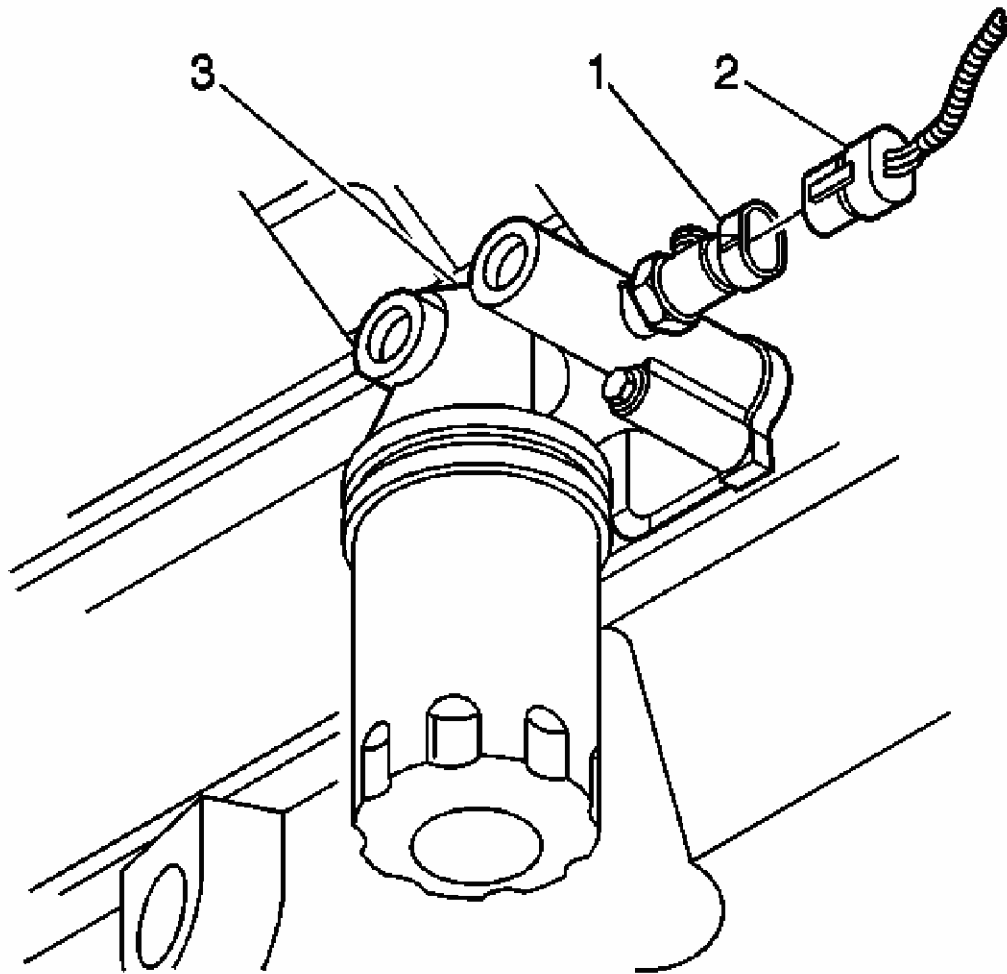


Fig. 114: View of Engine Oil Pressure Switch & Electrical Connector
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

1. Install the engine oil pressure switch (1) to the oil filter adapter (3).

Tighten: Tighten the engine oil pressure switch to 16 N.m (12 lb ft).

2. Connect the electrical connector (2) to the engine oil pressure switch (1).
3. Lower the vehicle.
4. Adjust the engine oil level to the full mark.
5. Inspect for oil leaks after engine start up.

ENGINE OIL LEVEL SENSOR AND/OR SWITCH REPLACEMENT

REMOVAL PROCEDURE

1. Remove the air conditioning (A/C) compressor. Refer to **Compressor Replacement (LD8)** or **Compressor Replacement (L26)**.
2. Drain the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.

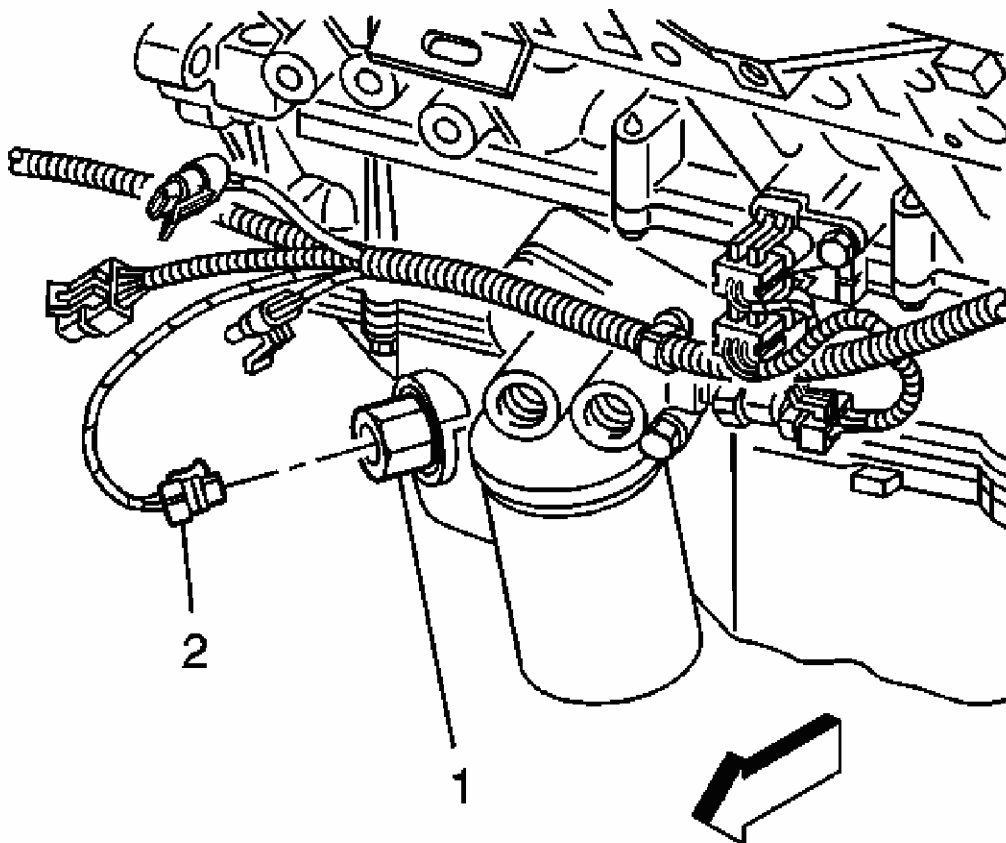


Fig. 115: View of Engine Oil Level Sensor & Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. Disconnect the electrical connector (2) from the engine oil level sensor (1).
4. Remove the engine oil level sensor (1) from the oil pan.

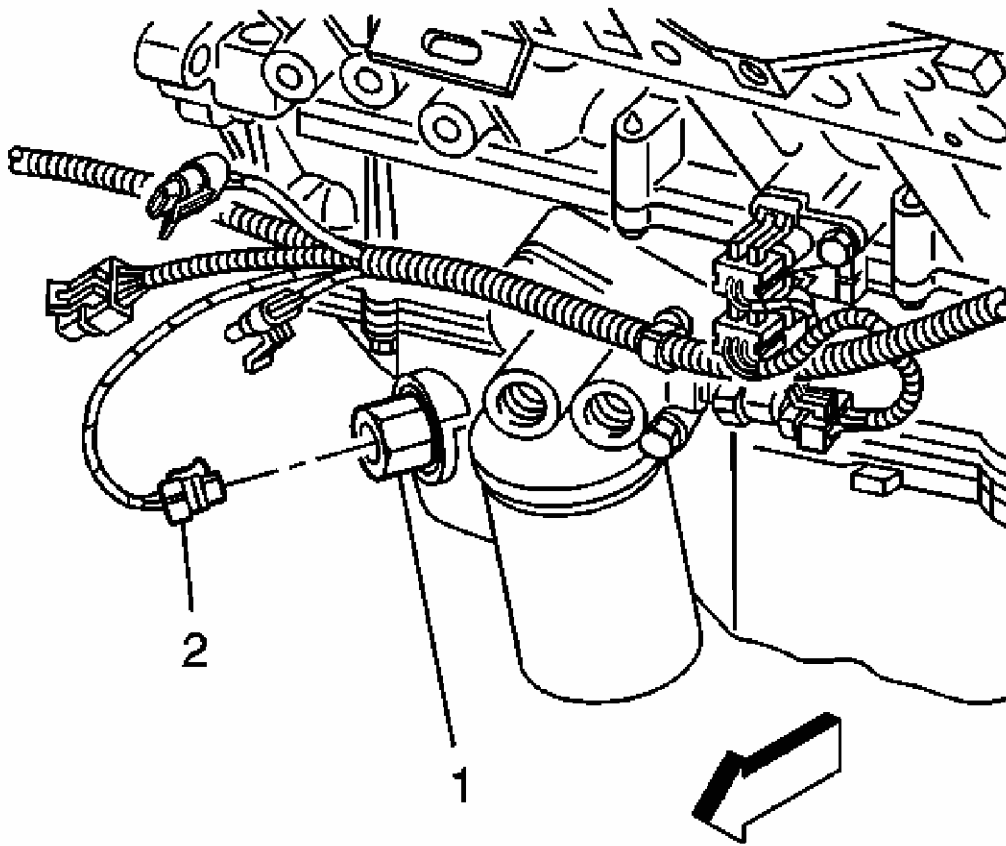
INSTALLATION PROCEDURE

Fig. 116: View of Engine Oil Level Sensor & Electrical Connector
Courtesy of GENERAL MOTORS CORP.

NOTE: Replacement components must be the correct part number for the application. Components requiring the use of the thread locking compound, lubricants, corrosion inhibitors or sealants are identified in the service procedure. Some replacement components may come with these coatings already applied. Do not use these coatings on components unless specified. These coatings can affect the final torque, which may affect the operation of the component. Use the correct torque specification when installing components in

order to avoid damage.

NOTE: **Refer to Fastener Notice .**

1. Install the engine oil level sensor (1) into the oil pan.

Tighten: Tighten the engine oil level sensor to 20 N.m (15 lb ft).

2. Connect the electrical connector (2) to the engine oil level sensor (1).
3. Fill the engine oil. Refer to **Engine Oil and Oil Filter Replacement** .
4. Install the A/C compressor. Refer to **Compressor Replacement (LD8)** or **Compressor Replacement (L26)** .
5. Inspect for oil leaks after engine start up.

OIL PUMP SUCTION PIPE AND SCREEN ASSEMBLY REPLACEMENT

REMOVAL PROCEDURE

1. Remove the engine oil pan. Refer to **Oil Pan Replacement**.

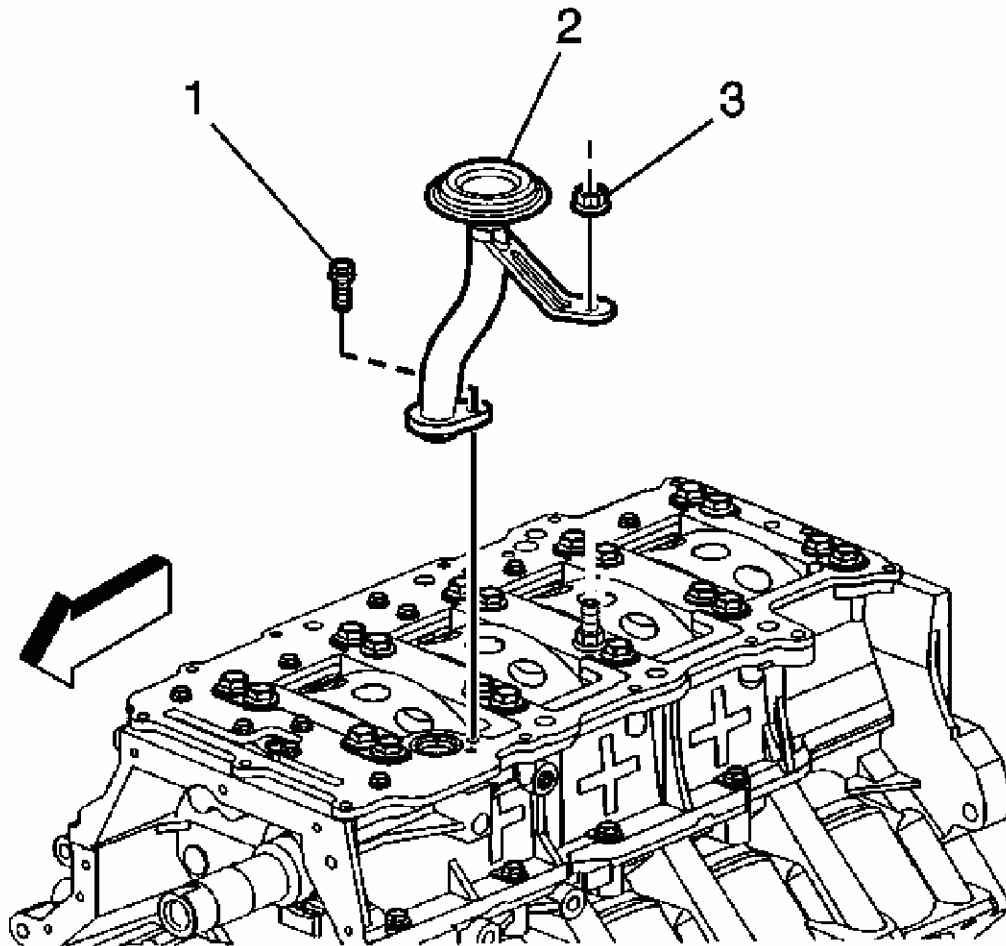


Fig. 117: Identifying Oil Pump Pickup Tube Support Nut, Oil Manifold Mounting Bolt & Oil Pump Pickup Tube
Courtesy of GENERAL MOTORS CORP.

2. Remove the oil pump pickup tube support nut (3) from the main bearing stud.
3. Remove the mounting bolt (1) from the oil manifold plate.
4. Remove the oil pump pickup tube (2).

INSTALLATION PROCEDURE

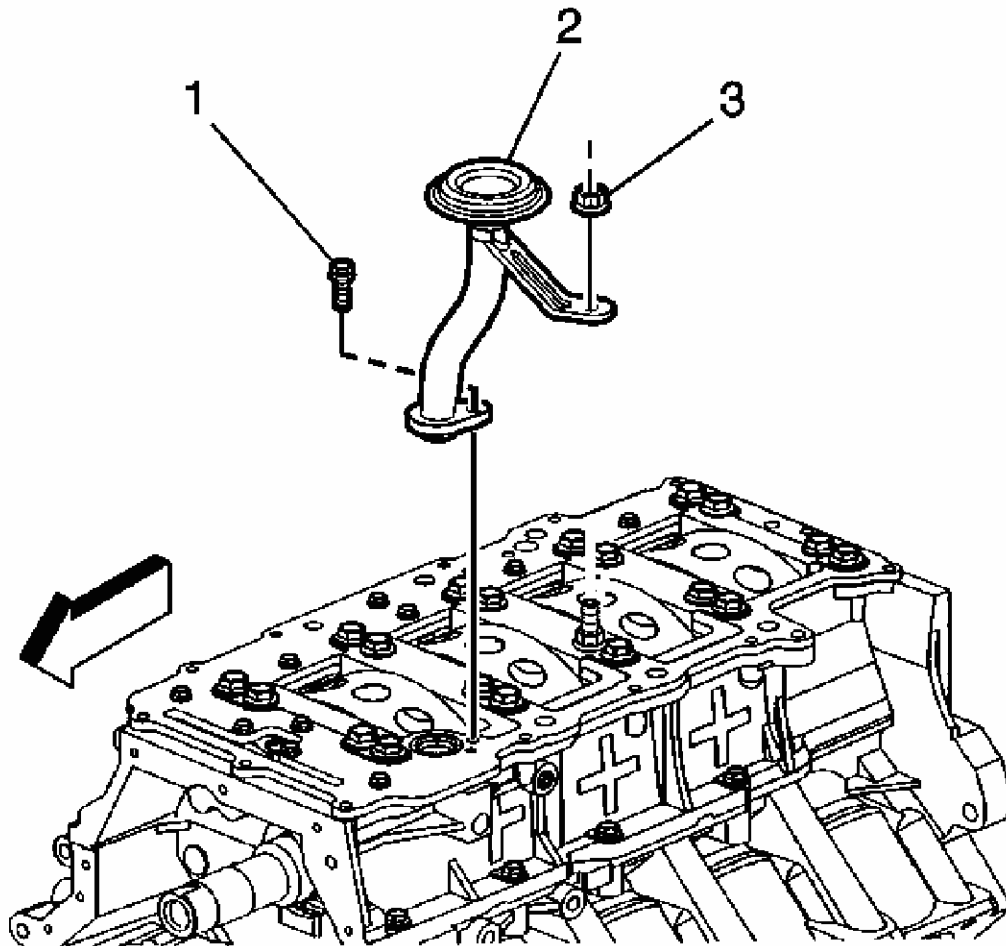


Fig. 118: Identifying Oil Pump Pickup Tube Support Nut, Oil Manifold Mounting Bolt & Oil Pump Pickup Tube
 Courtesy of GENERAL MOTORS CORP.

1. Lubricate the silicone seal in the oil manifold plate.

With a twisting motion, install the end of the oil pump pick-up tube (2).

NOTE: Refer to FASTENER NOTICE .

2. Install the oil pump pick-up retaining bolt (1) and nut (3).

Tighten:

- Tighten the oil pump pick-up tube nut to 24 N.m (18 lb ft).

- Tighten the oil pump pick-up tube bolt to 10 N.m (89 lb in).

3. Install the oil pan. Refer to **Oil Pan Replacement**.

CAMSHAFT COVER REPLACEMENT - LEFT SIDE

TOOLS REQUIRED

- **J 38823** Water Pump Drive Pulley Installer. See **Special Tools** .
- **J 38825** Water Pump Drive Pulley Remover. See **Special Tools** .

REMOVAL PROCEDURE

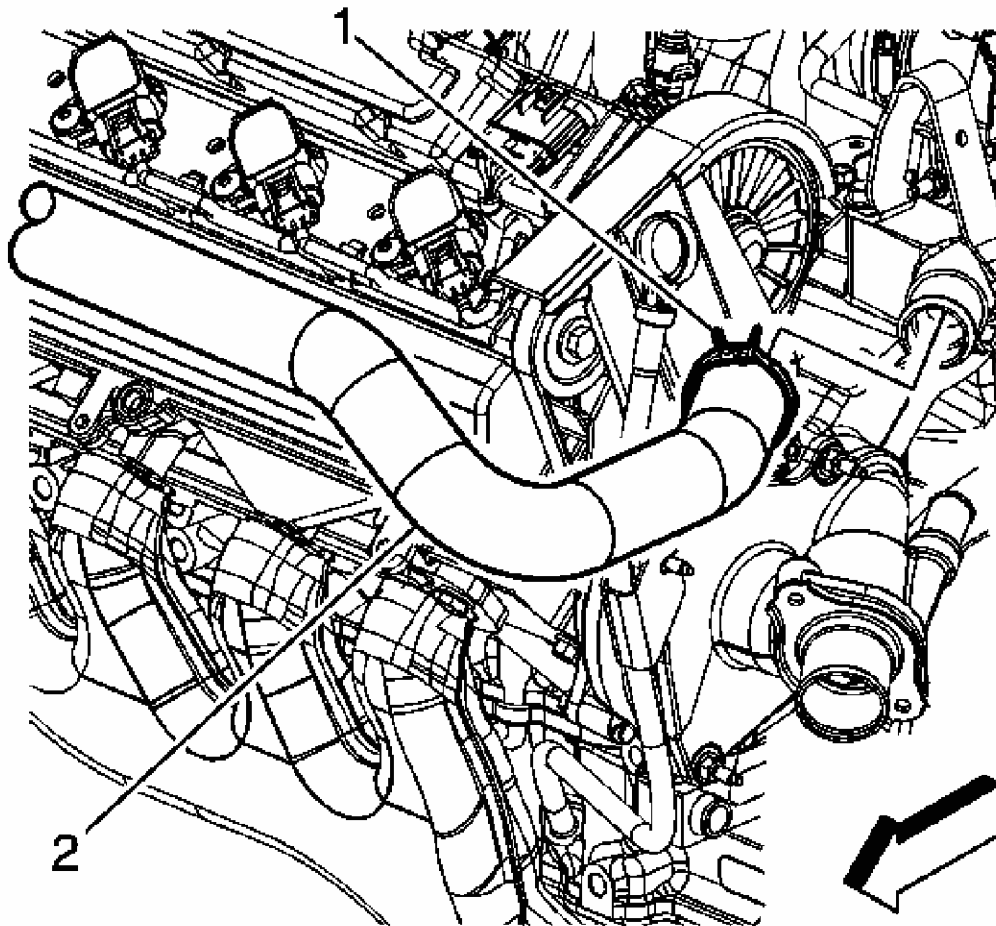


Fig. 119: View Of Radiator Inlet Hose & Clamp
Courtesy of GENERAL MOTORS CORP.

1. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.
2. Remove the upper tie bar. Refer to **Front End Upper Tie Bar Replacement**.
3. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** or **Cooling System Draining and Filling (Vac-N-Fill)**.
4. Reposition the radiator inlet hose clamp (1).
5. Remove the radiator inlet hose (2) from the water pump housing.

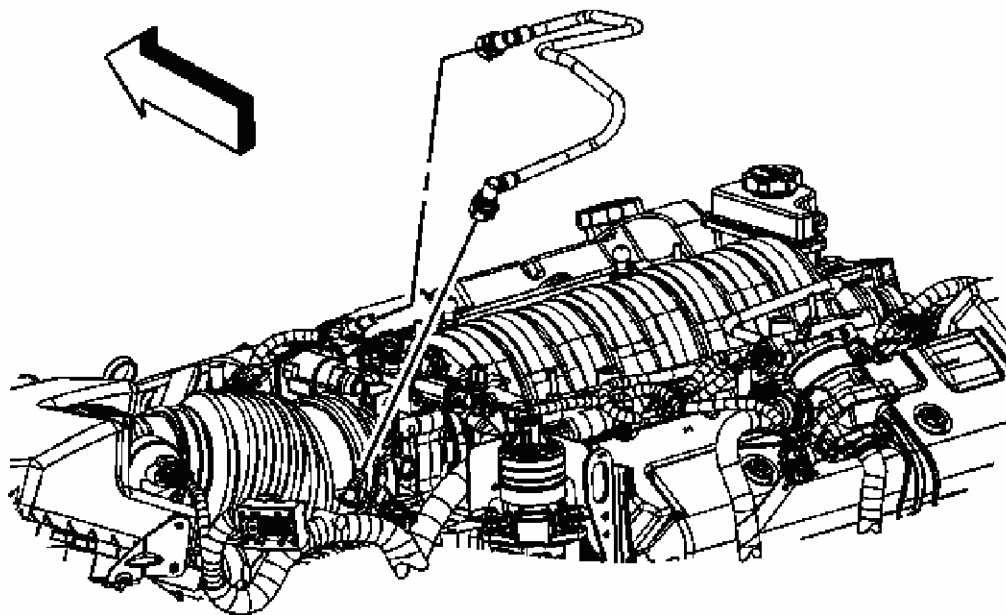


Fig. 120: Identifying PCV Fresh Air Tube
Courtesy of GENERAL MOTORS CORP.

6. Disconnect the positive crankcase ventilation (PCV) fresh air tube quick connect fitting from the camshaft cover. Refer to **Plastic Collar Quick Connect Fitting Service**.
7. Remove the ignition coils. Refer to **Ignition Coil Replacement - Bank 2**.

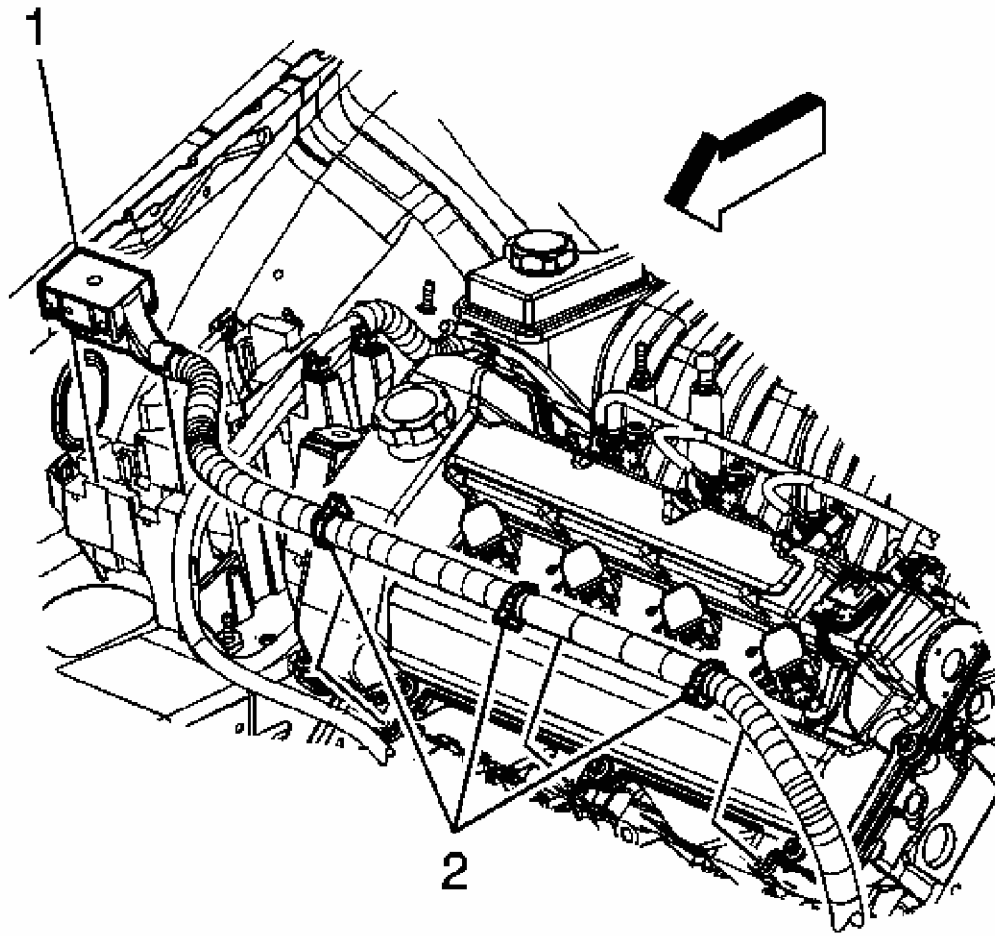


Fig. 121: View Of Engine Harness & Clips
Courtesy of GENERAL MOTORS CORP.

8. Remove the engine harness clips (2) from the camshaft cover and position the harness aside.

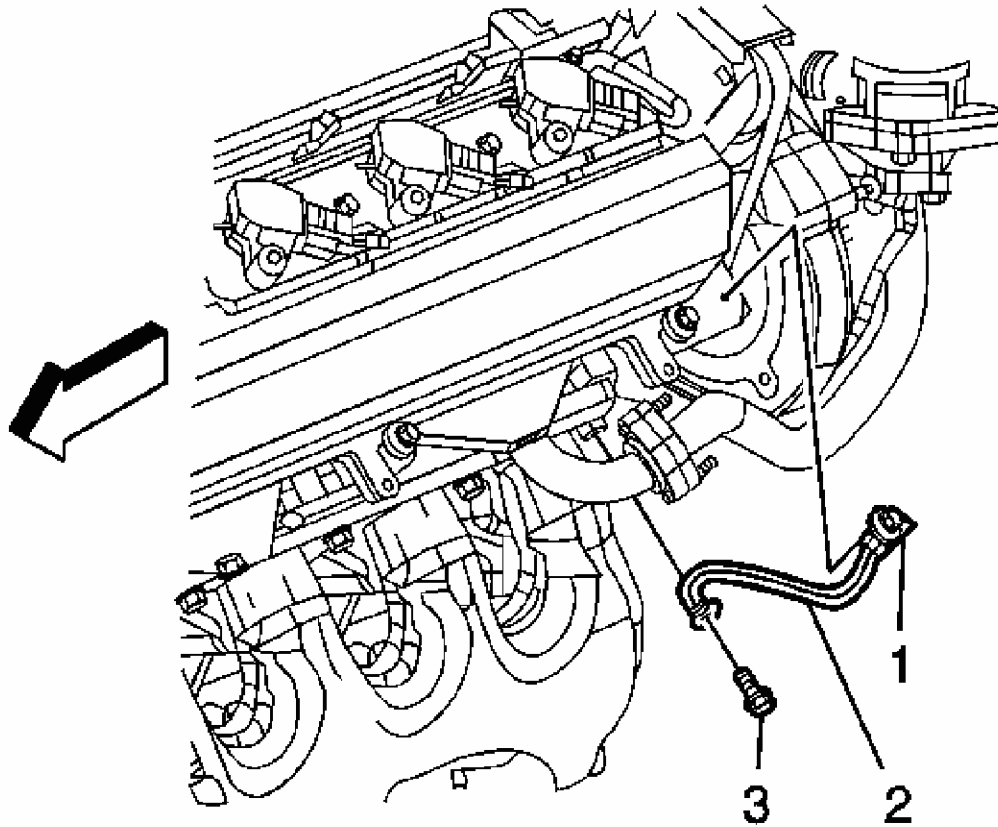


Fig. 122: Identifying ICM Wiring Harness Ground
Courtesy of GENERAL MOTORS CORP.

9. Loosen the ignition control module (ICM) wiring harness ground bolt (1) from the camshaft cover.
10. Remove the ground wire terminal/bolt from the camshaft cover.

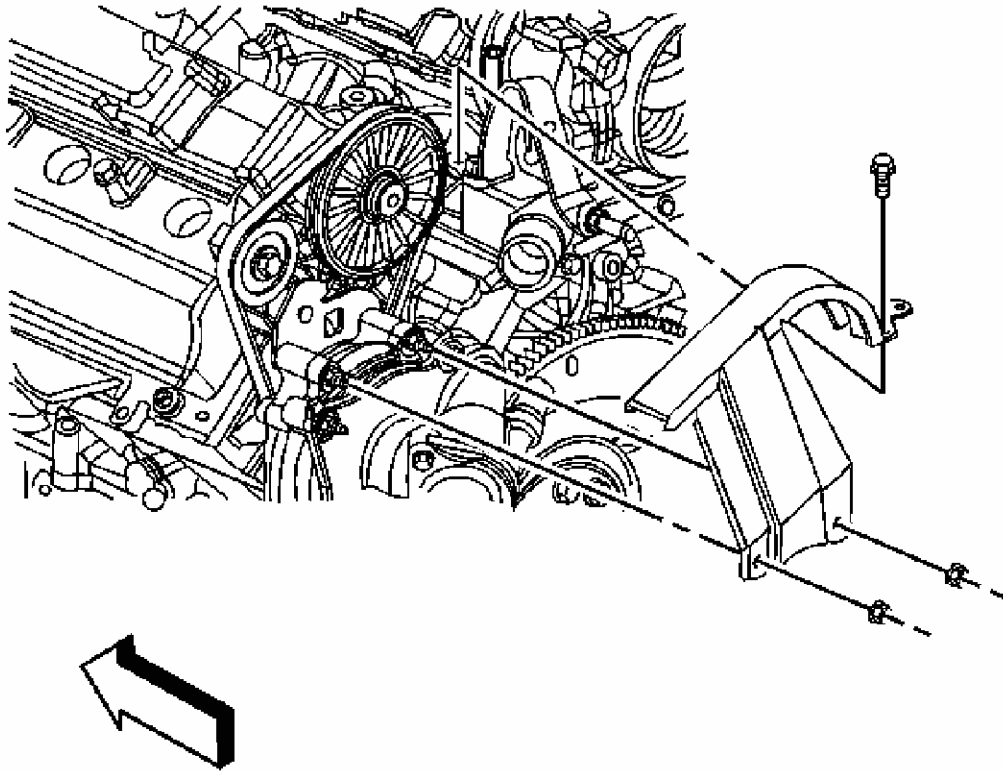


Fig. 123: View Of Water Pump Drive Belt Tensioner Shield
Courtesy of GENERAL MOTORS CORP.

11. Remove the water pump drive belt tensioner shield bolt/nuts.
12. Remove the water pump drive belt shield.
13. Remove the water pump drive belt from the pulleys.

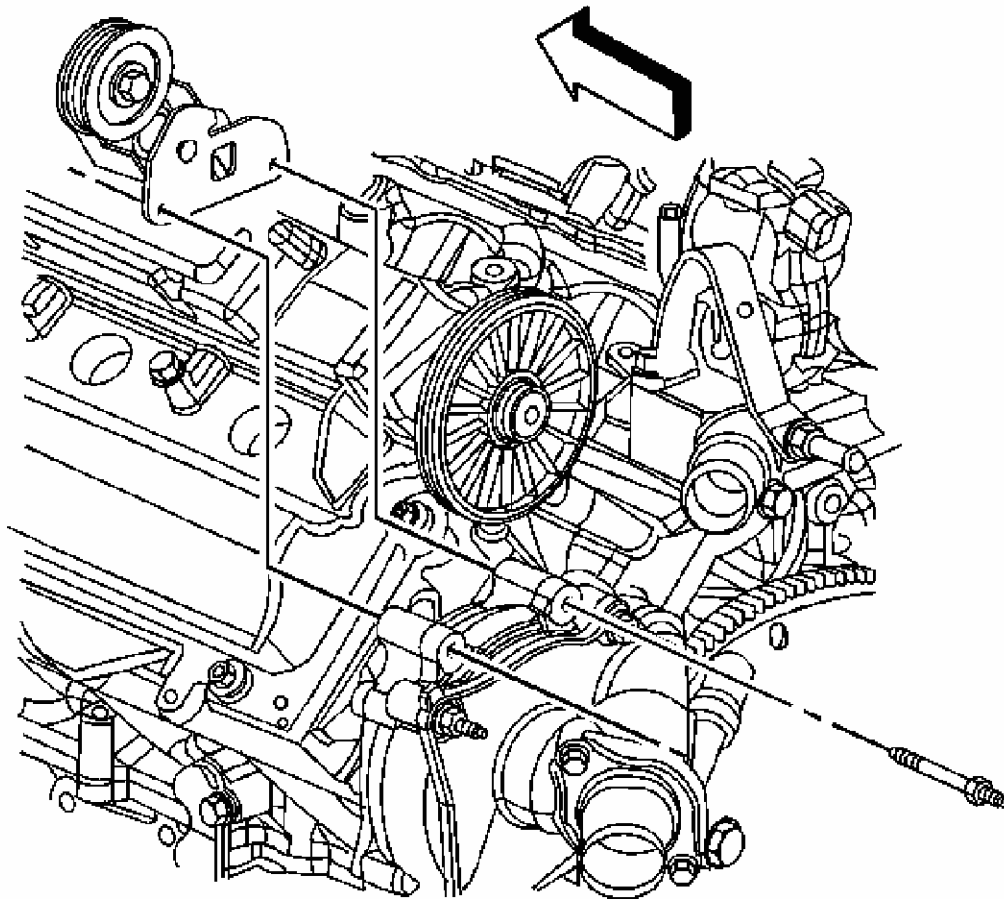


Fig. 124: View Of Water Pump Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

14. Remove the water pump drive belt tensioner studs.
15. Remove the water pump belt tensioner.

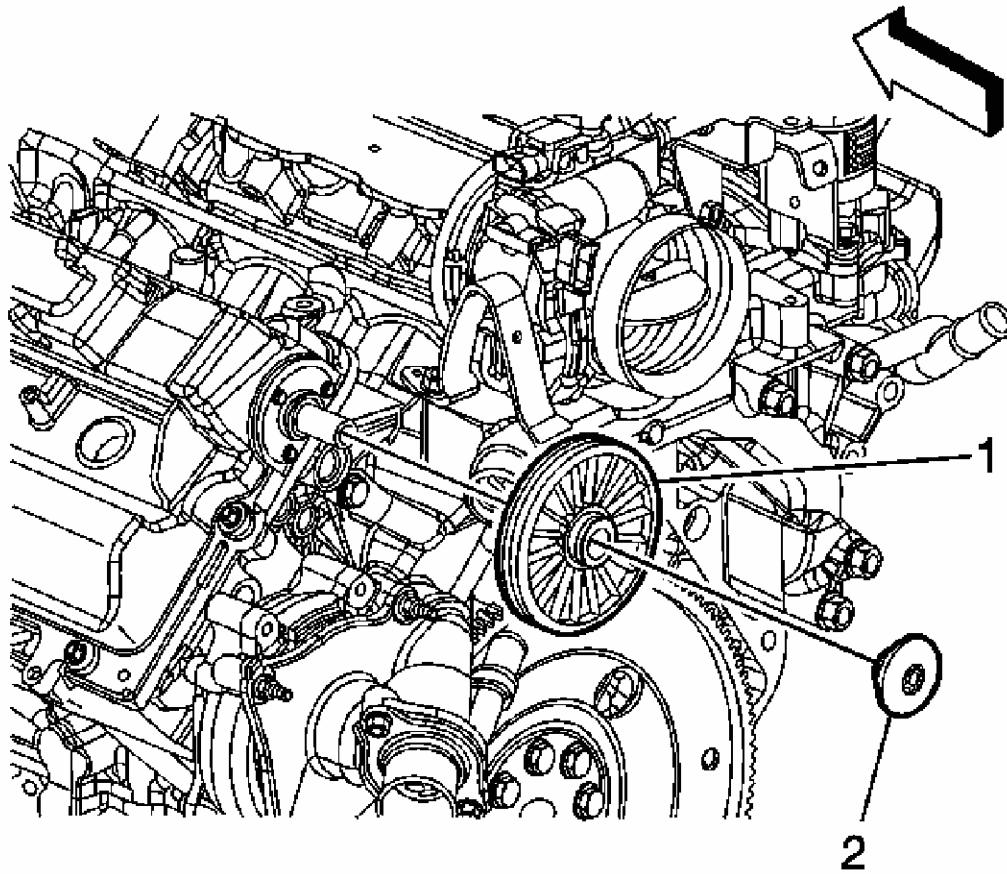


Fig. 125: Identifying Plastic Dust Cap
Courtesy of GENERAL MOTORS CORP.

16. Remove the plastic dust cap (2) from the end of the intake camshaft.

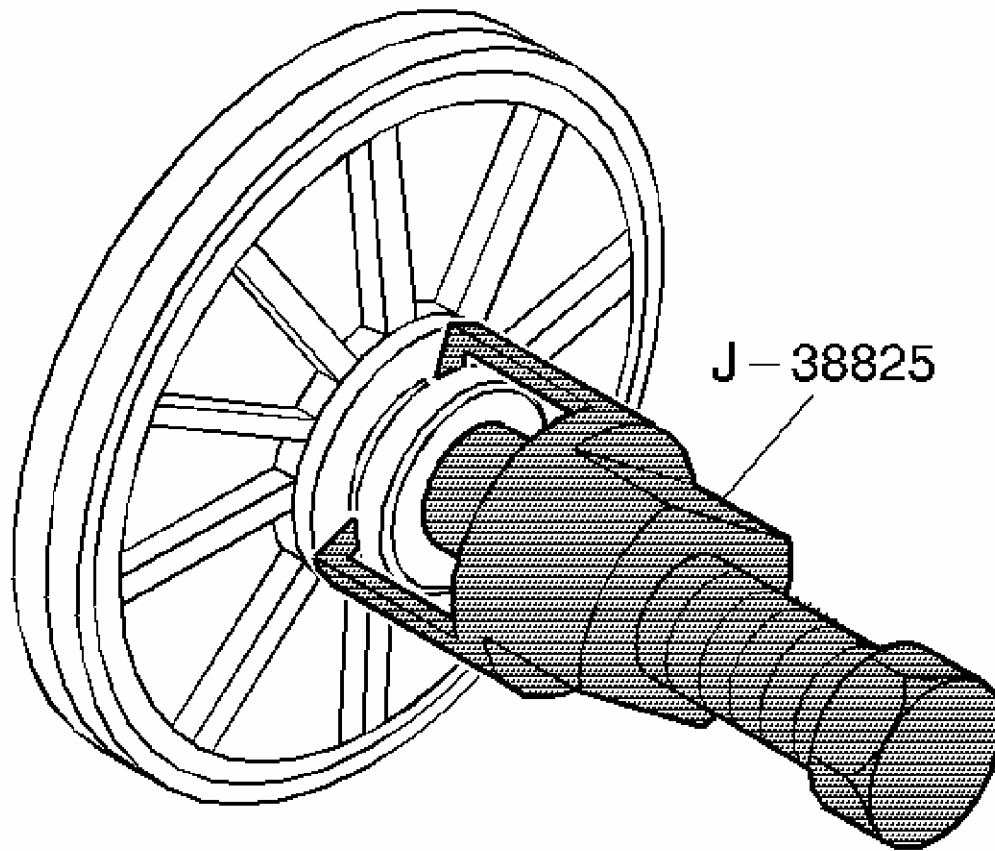


Fig. 126: View of J 38825

Courtesy of GENERAL MOTORS CORP.

17. Remove the water pump pulley from the intake camshaft using the **J 38825** . See **Special Tools** .

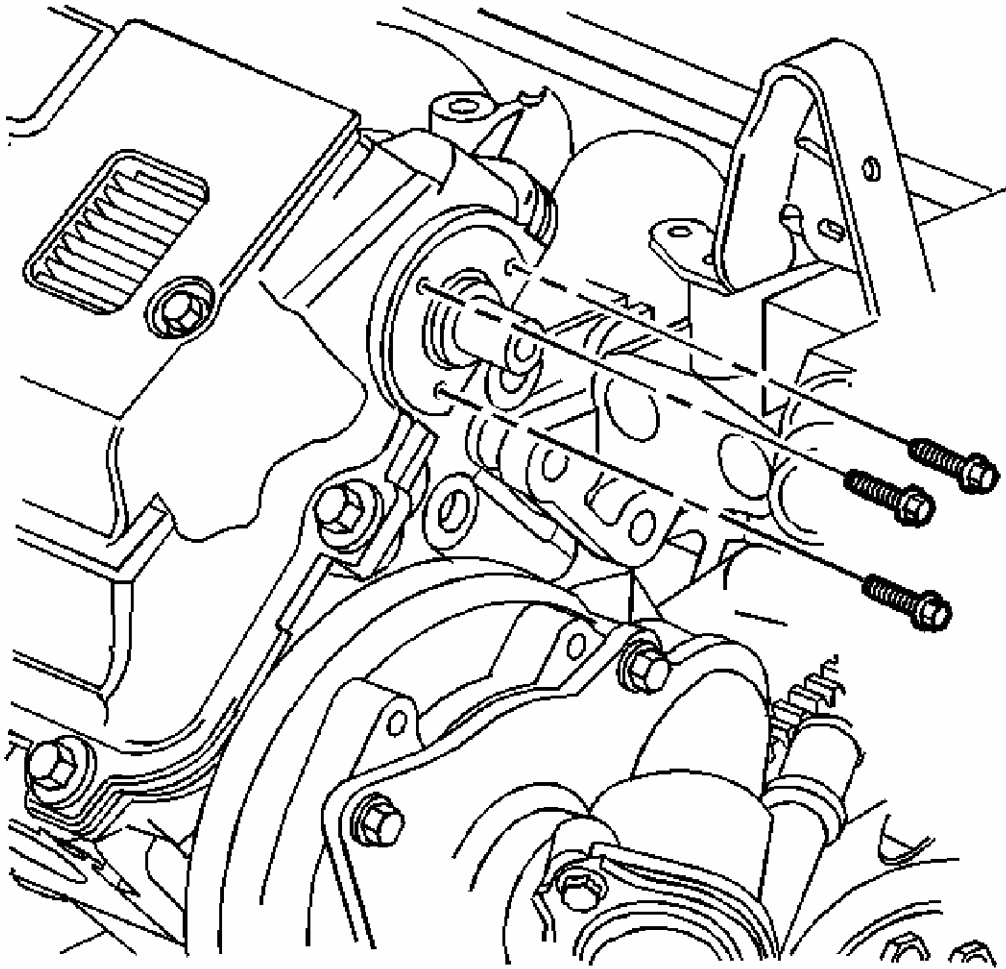


Fig. 127: Identifying Camshaft Seal Retainer Bolts
Courtesy of GENERAL MOTORS CORP.

18. Remove the camshaft seal bolts.

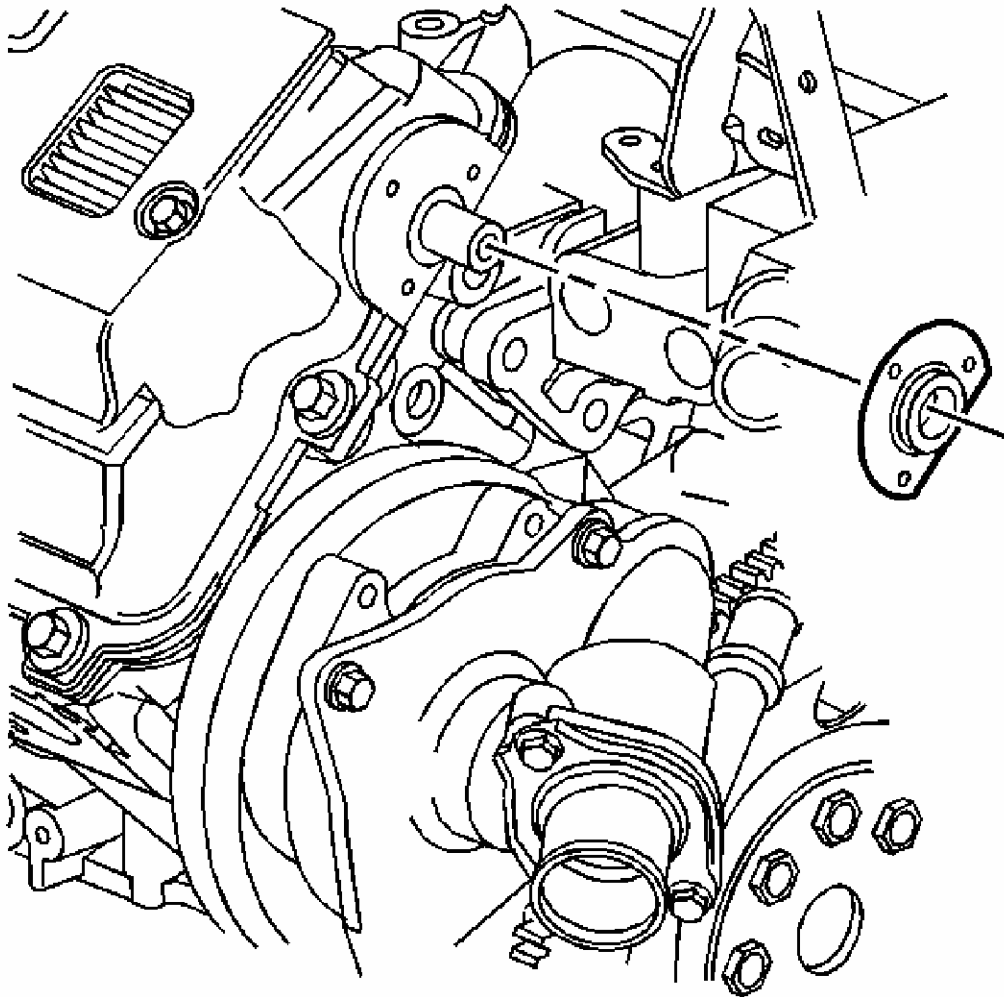


Fig. 128: View of Camshaft Seal
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: DO NOT reuse the camshaft seal.

19. Remove and discard the camshaft seal.

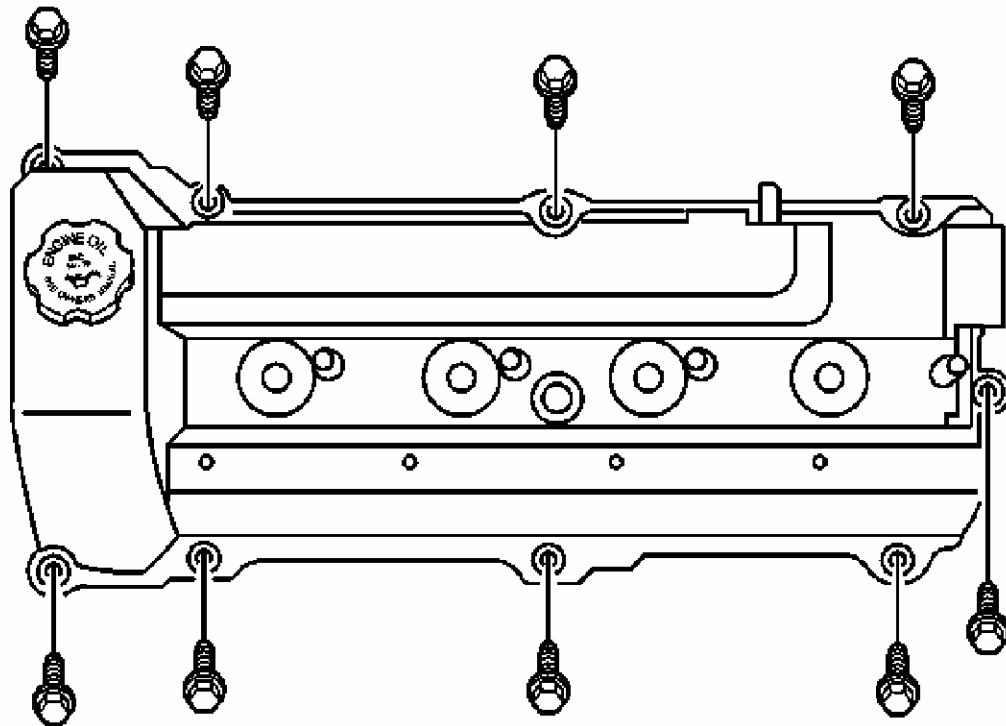


Fig. 129: View of Camshaft Cover Bolts
Courtesy of GENERAL MOTORS CORP.

20. Loosen the camshaft cover bolts.

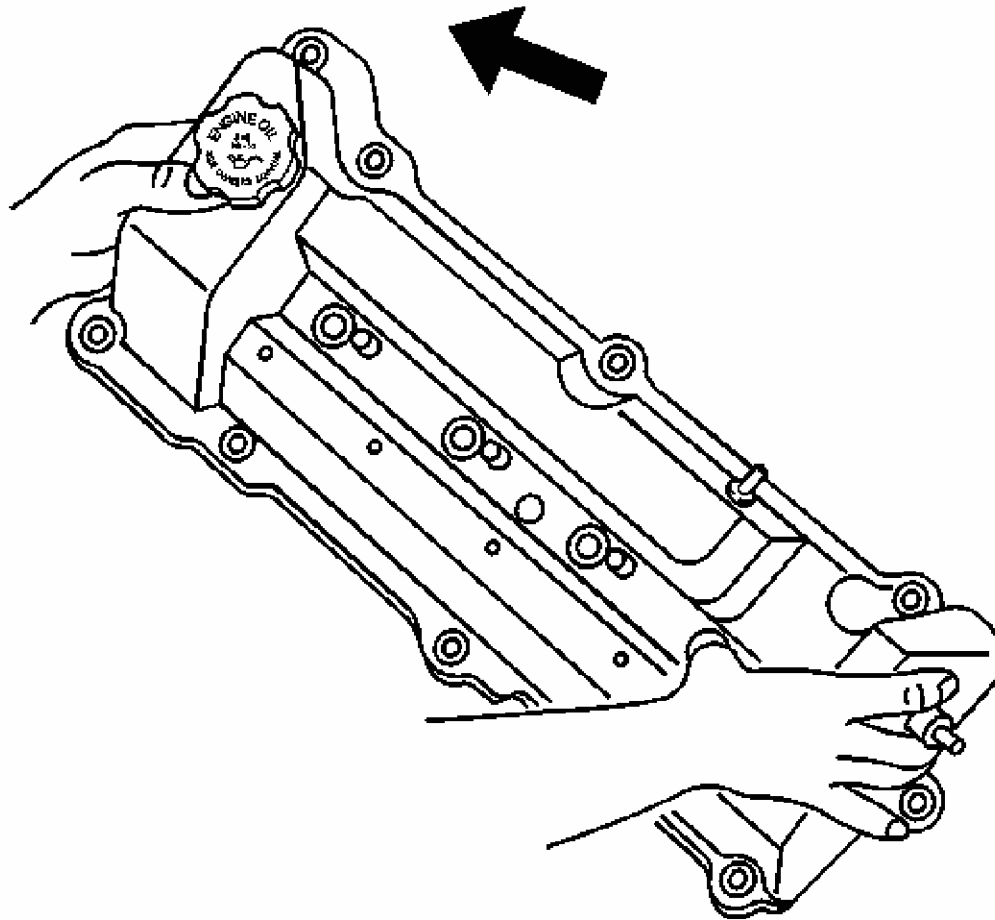


Fig. 130: Identifying Camshaft Drive End of Camshaft Cover
Courtesy of GENERAL MOTORS CORP.

21. Lift the camshaft drive end of the cover up.

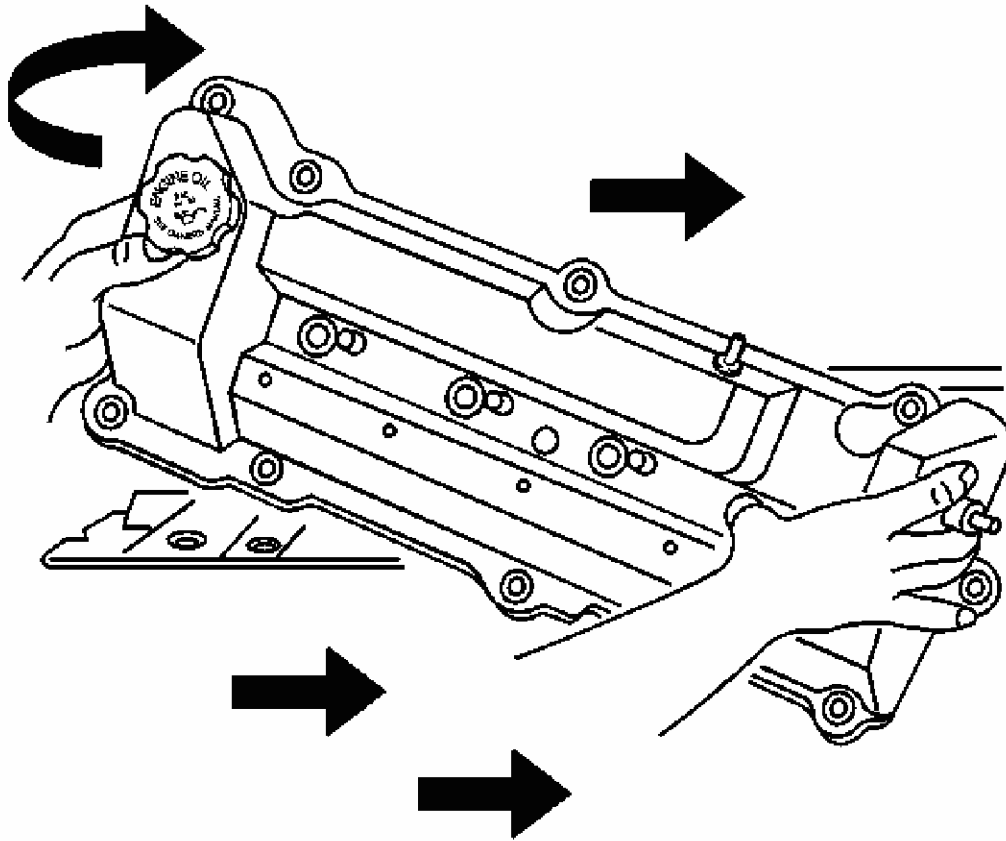


Fig. 131: Moving Left Camshaft Cover Rearward
Courtesy of GENERAL MOTORS CORP.

22. Move the camshaft cover rearward in order to clear the water pump drive shaft.
23. Discard the camshaft cover perimeter seals and spark plug seals if there is any evidence of damage or if the seal comes out of the groove in the cover during removal.
24. Clean and inspect the camshaft cover. Refer to **Camshaft Cover Cleaning and Inspection** .

INSTALLATION PROCEDURE

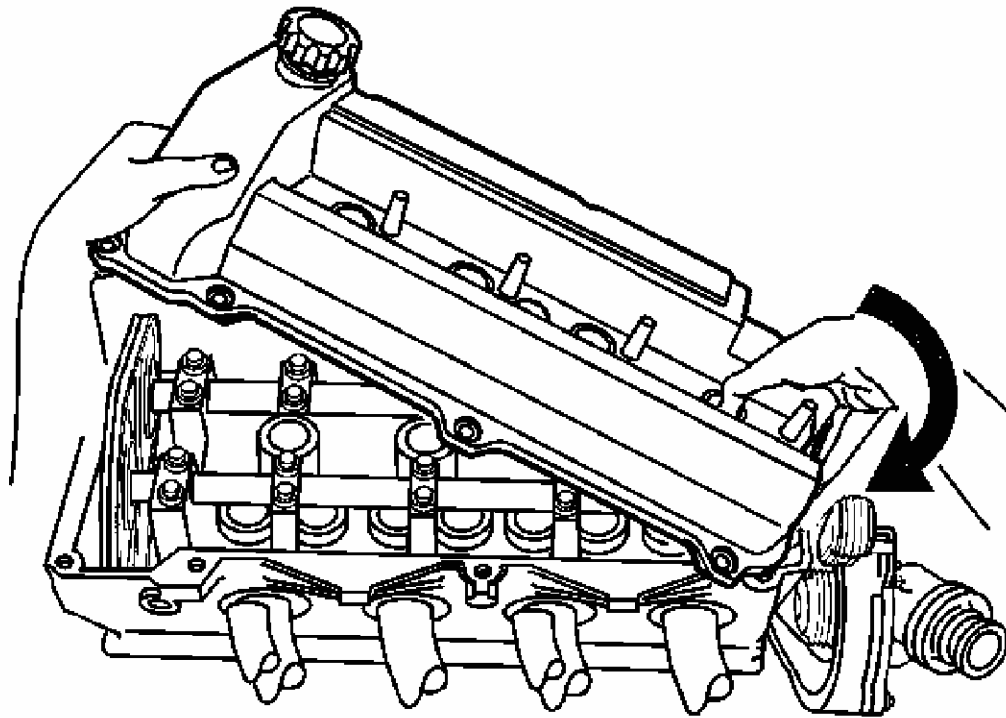


Fig. 132: View of Intake Camshaft
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Be careful to prevent the exposed section of the camshaft cover seal from being damaged by the edge of the cylinder head casting.

1. Install the camshaft cover seal as required.
2. Install the camshaft cover end over the intake camshaft end.

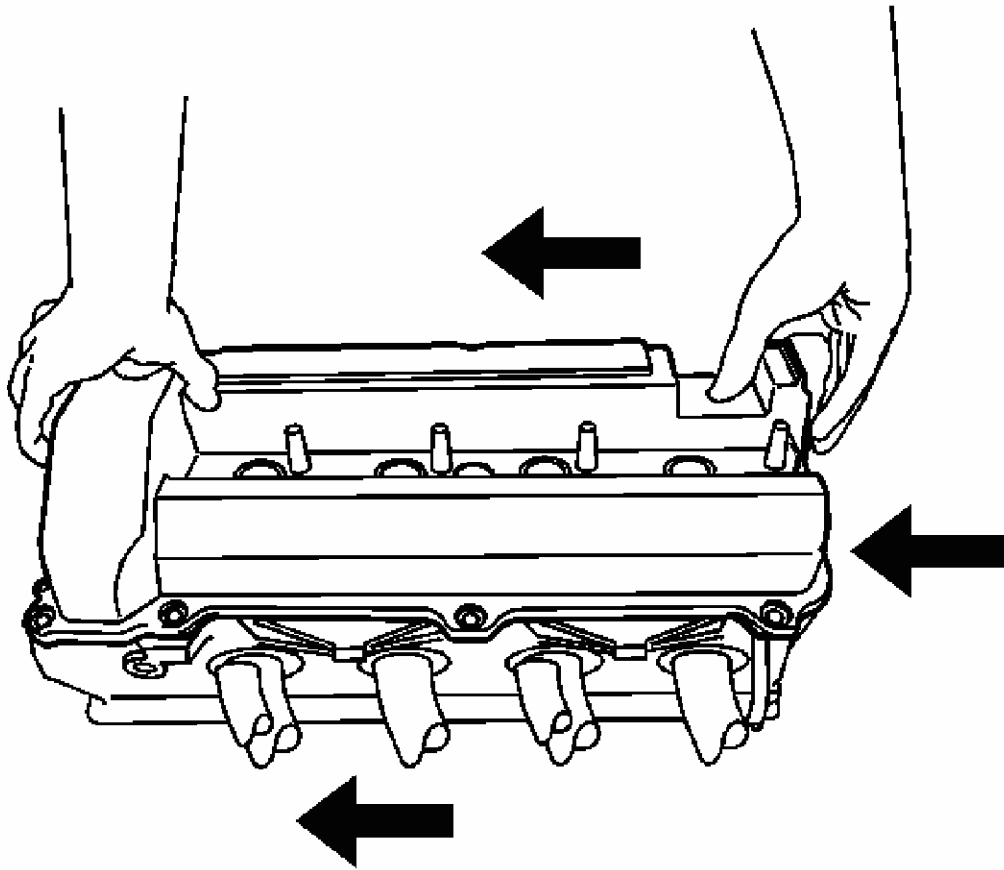


Fig. 133: Proper Positioning of Camshaft Cover
Courtesy of GENERAL MOTORS CORP.

3. Work the camshaft cover into position by pivoting the cover down and to the left allowing the cover to clear the camshaft drive chain and then aligning the bolt holes.

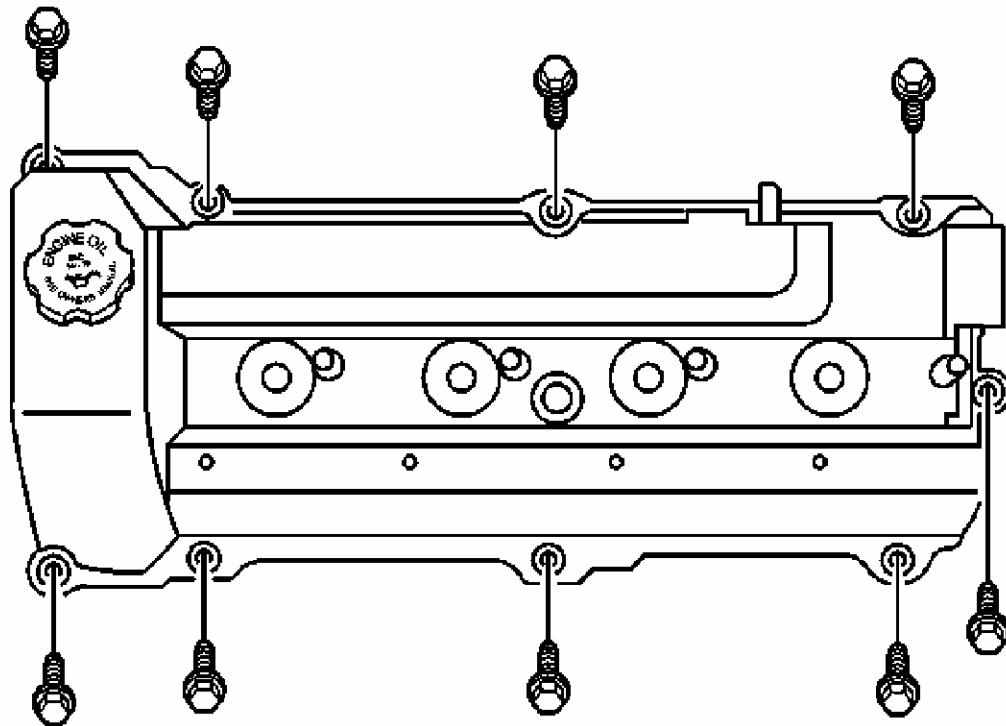


Fig. 134: View of Camshaft Cover Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

4. Tighten the camshaft cover bolts.

Tighten: Tighten the bolts to 10 N.m (89 lb in).

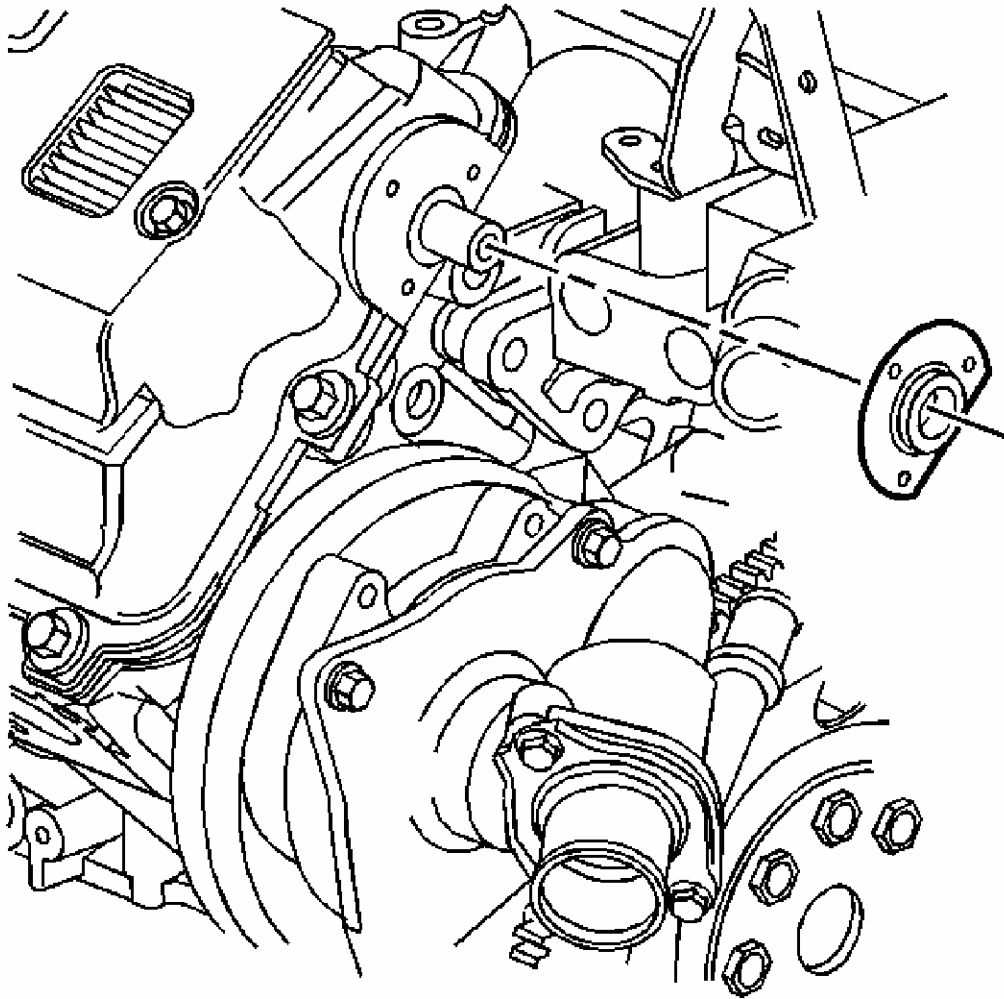


Fig. 135: View of Camshaft Seal
Courtesy of GENERAL MOTORS CORP.

5. Install a NEW camshaft seal as follows:
 1. Lubricate the camshaft seal lip with engine oil.
 2. Push the camshaft seal into position around the camshaft using the protective sleeve supplied with the seal.

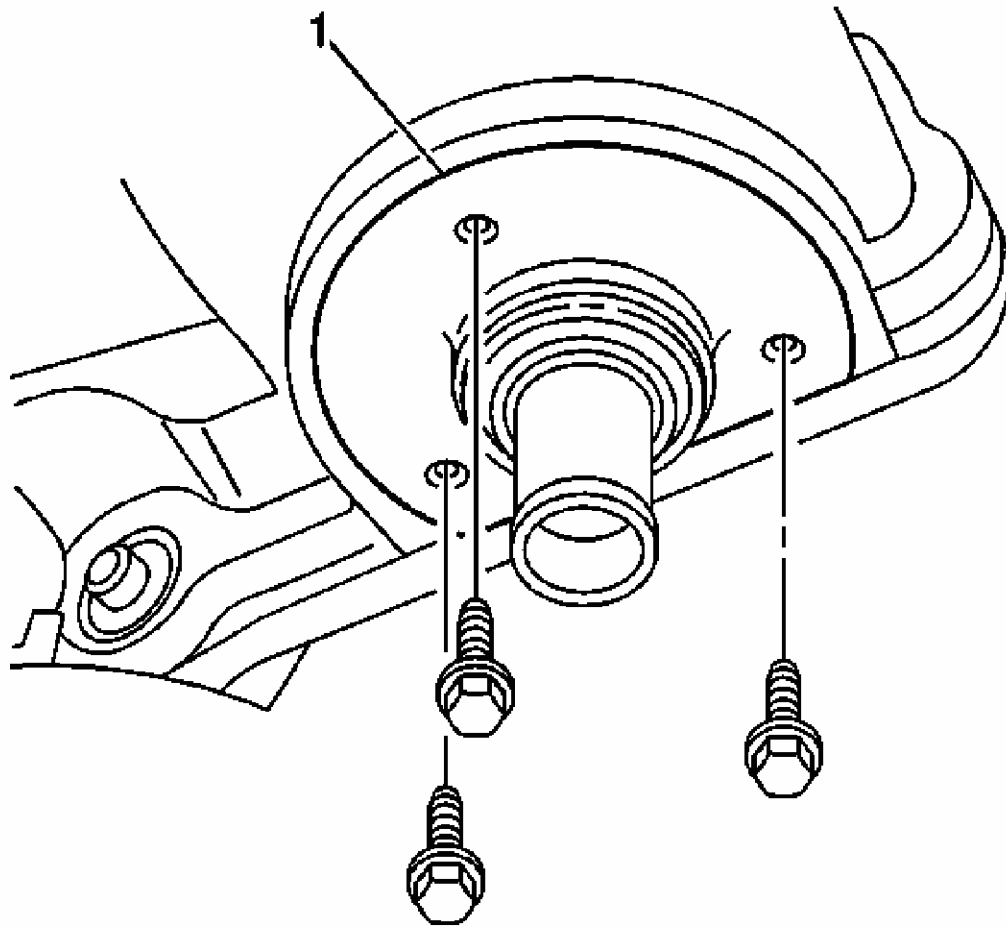


Fig. 136: Identifying Camshaft Seal Bolts
Courtesy of GENERAL MOTORS CORP.

6. Coat the threads of the camshaft seal bolts with sealant. Refer to **Sealers, Adhesives and Lubricants** .
7. Install the camshaft seal (1) bolts.

Tighten: Tighten the bolts to 3 N.m (27 lb in).

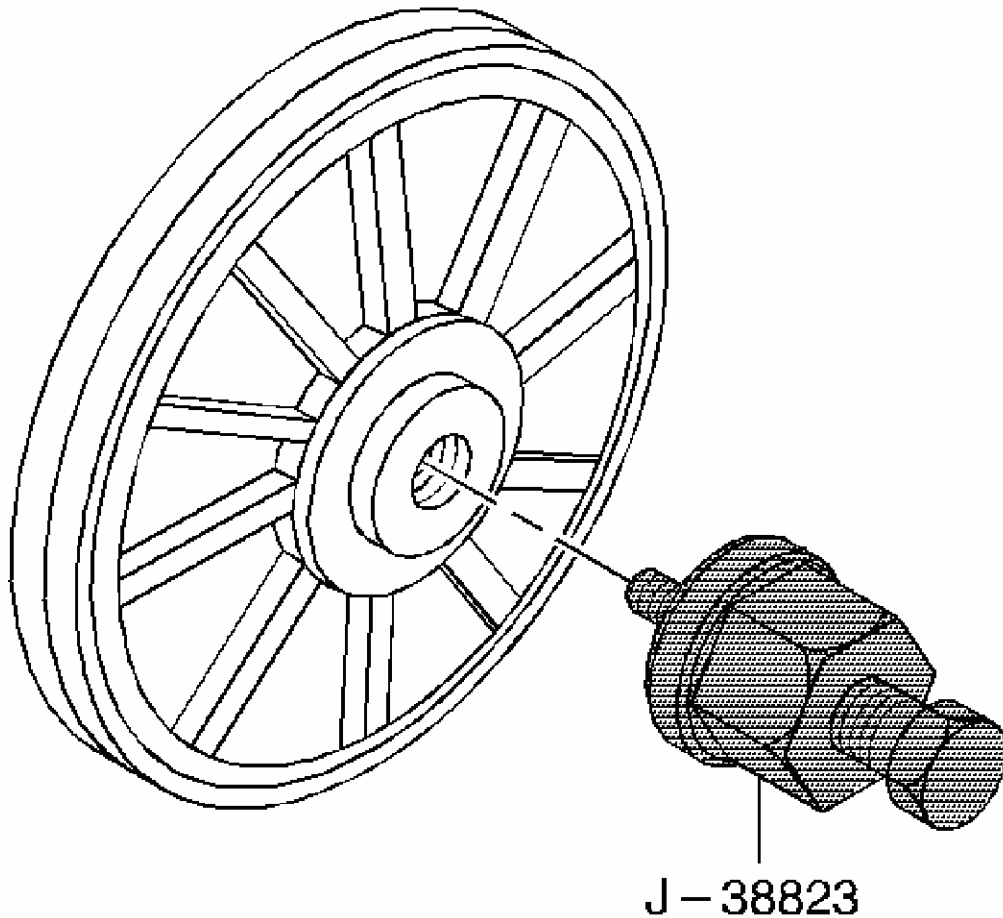


Fig. 137: View of J 38823 Installing Water Pump Pulley
Courtesy of GENERAL MOTORS CORP.

8. Install the water pump drive pulley onto the intake camshaft.
9. Install the water pump pulley using the **J 38823** . See **Special Tools** . During installation, the tool will bottom out on the camshaft at the proper depth.

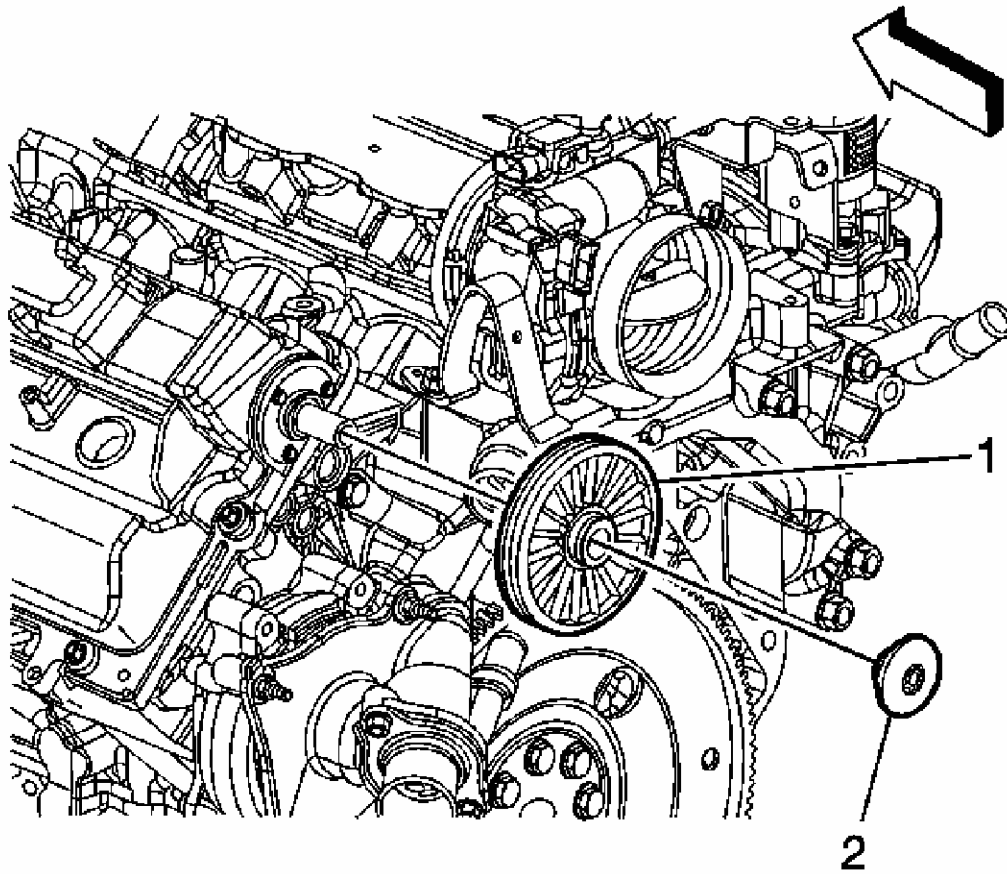


Fig. 138: Identifying Plastic Dust Cap
Courtesy of GENERAL MOTORS CORP.

10. Install the plastic dust cap (2) into the end of the camshaft.

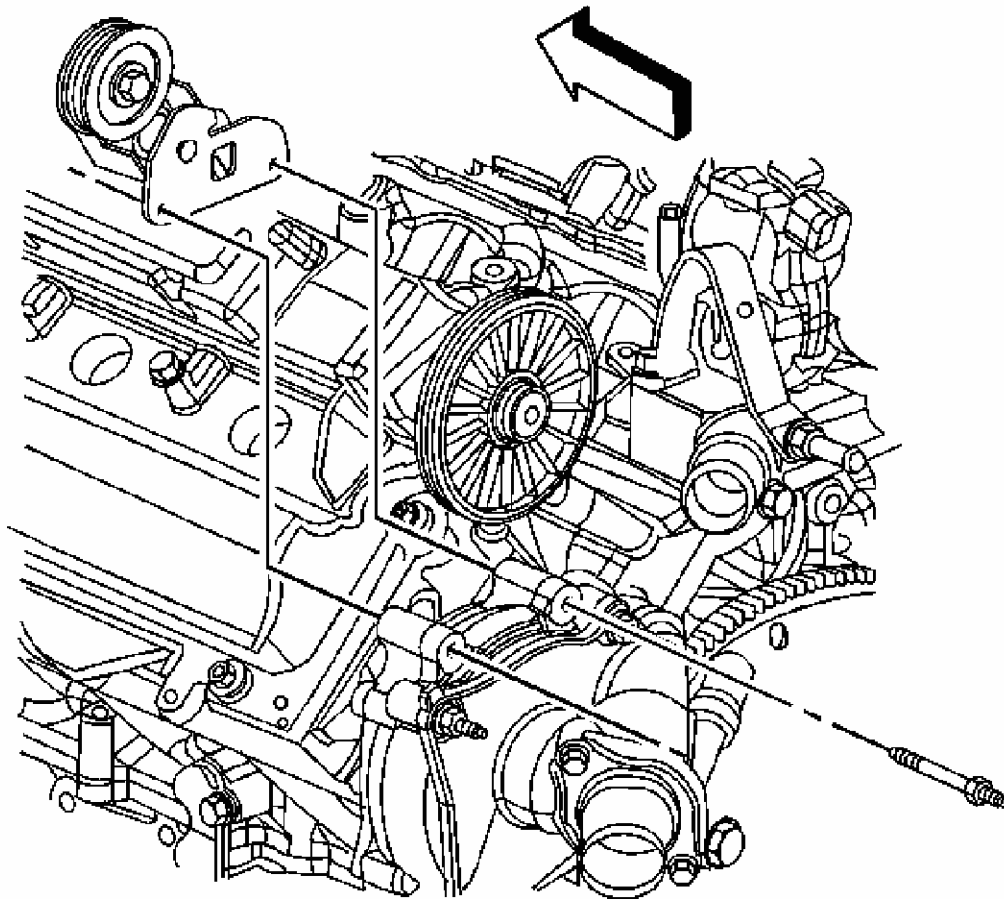


Fig. 139: View Of Water Pump Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

11. Position the water pump drive belt tensioner to the water pump housing.
12. Install the water pump drive belt tensioner studs.

Tighten: Tighten the studs to 10 N.m (89 lb in).

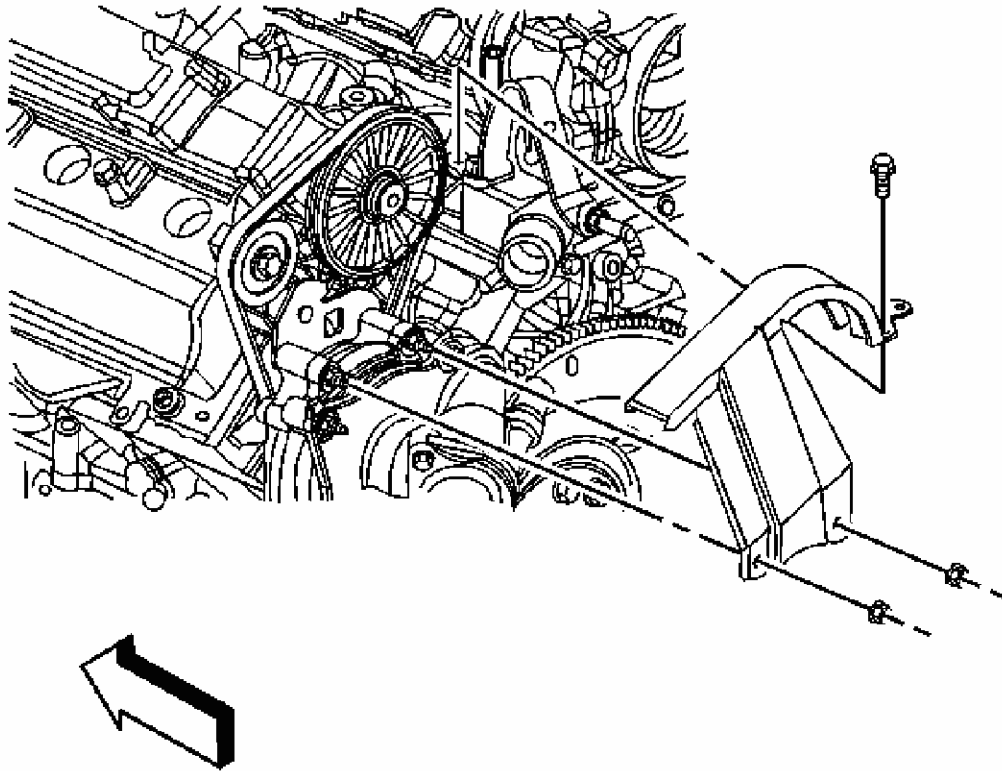


Fig. 140: View Of Water Pump Drive Belt Tensioner Shield
Courtesy of GENERAL MOTORS CORP.

13. Install the water pump drive belt over the pulleys.
14. Install the water pump drive belt shield over the tensioner studs.
15. Install the water pump drive belt shield bolt/nuts.

Tighten: Tighten the bolt/nuts to 10 N.m (89 lb in).

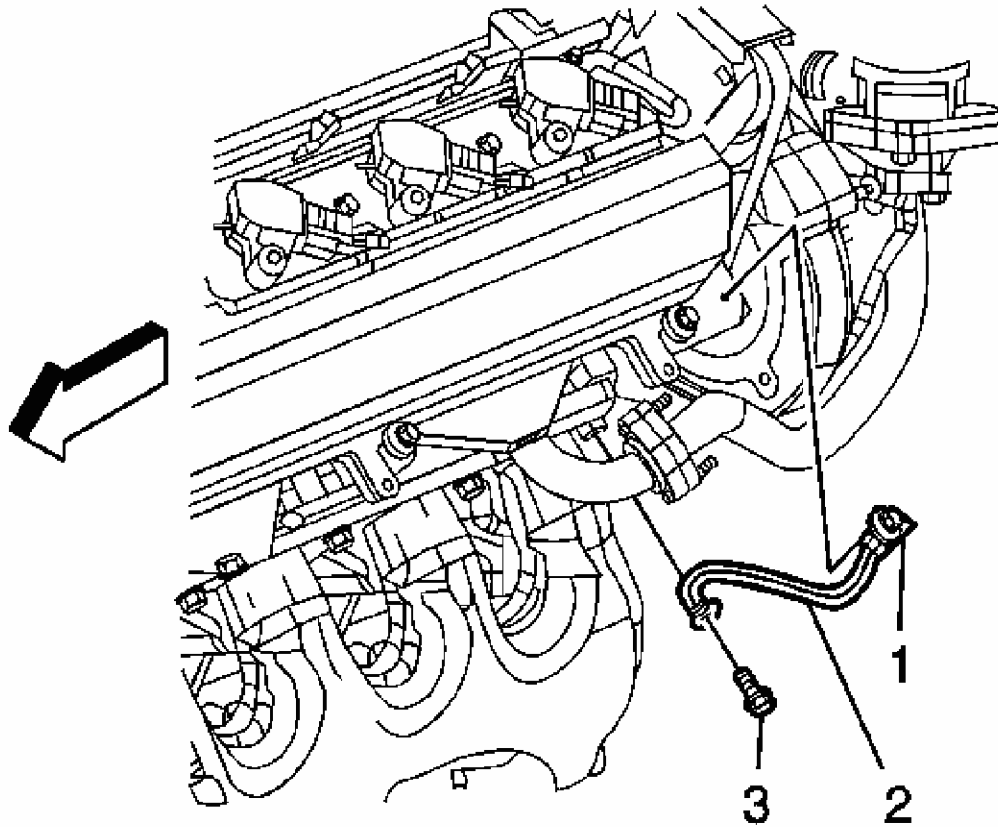


Fig. 141: Identifying ICM Wiring Harness Ground
Courtesy of GENERAL MOTORS CORP.

16. Position the ground wire terminal/bolt to the camshaft cover.
17. Tighten the ignition control module (ICM) wiring harness ground bolt (1) to the camshaft cover.

Tighten: Tighten the bolt to 10 N.m (89 lb in).

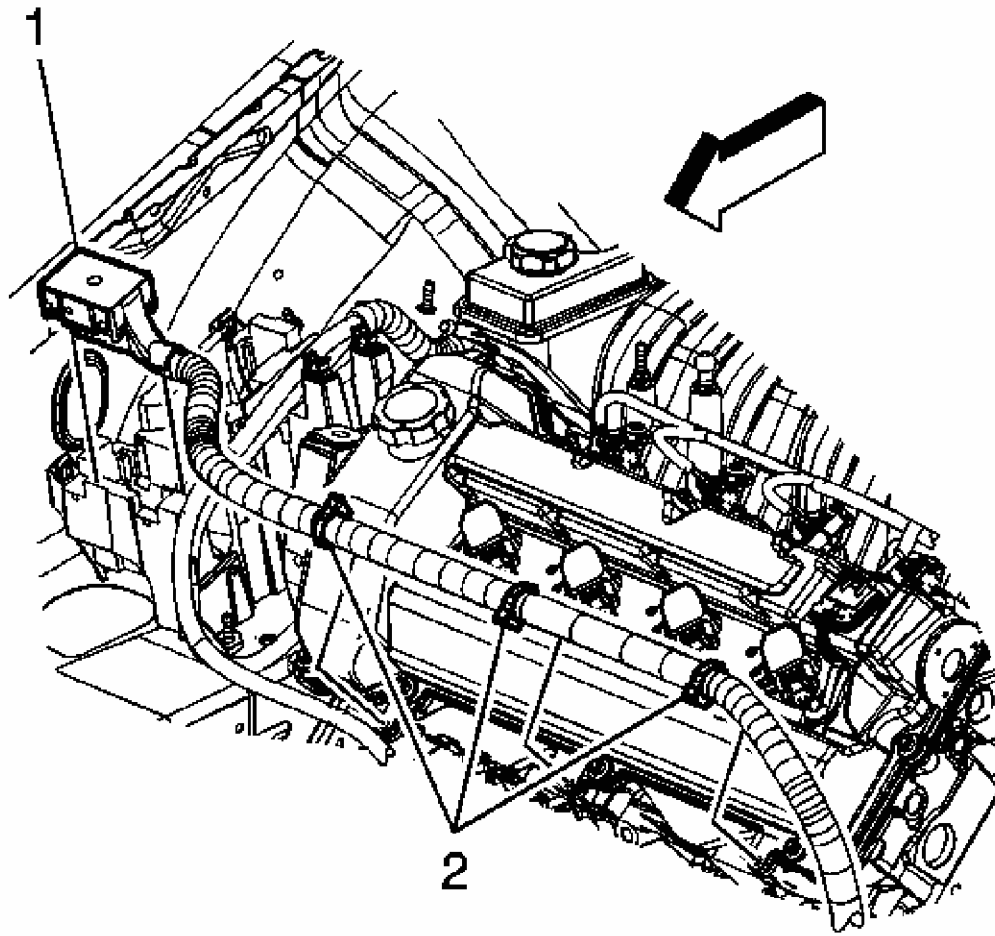


Fig. 142: View Of Engine Harness & Clips
Courtesy of GENERAL MOTORS CORP.

18. Position the engine harness and install the engine harness clips (2) to the camshaft cover.
19. Install the ignition coils. Refer to **Ignition Coil Replacement - Bank 2** .

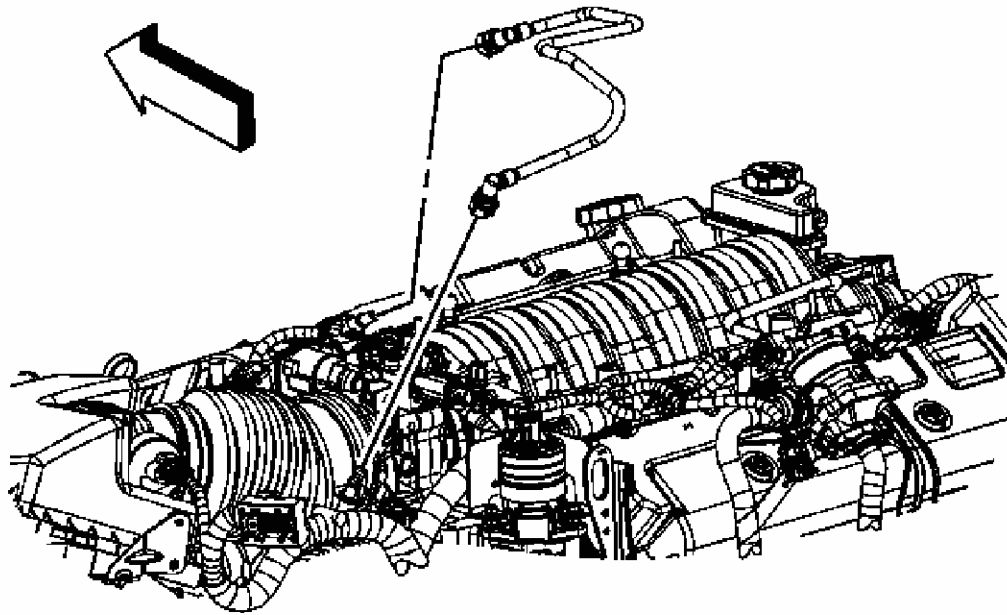


Fig. 143: Identifying PCV Fresh Air Tube
Courtesy of GENERAL MOTORS CORP.

20. Connect the PCV fresh air tube quick connect fitting to the camshaft cover. Refer to **Plastic Collar Quick Connect Fitting Service**

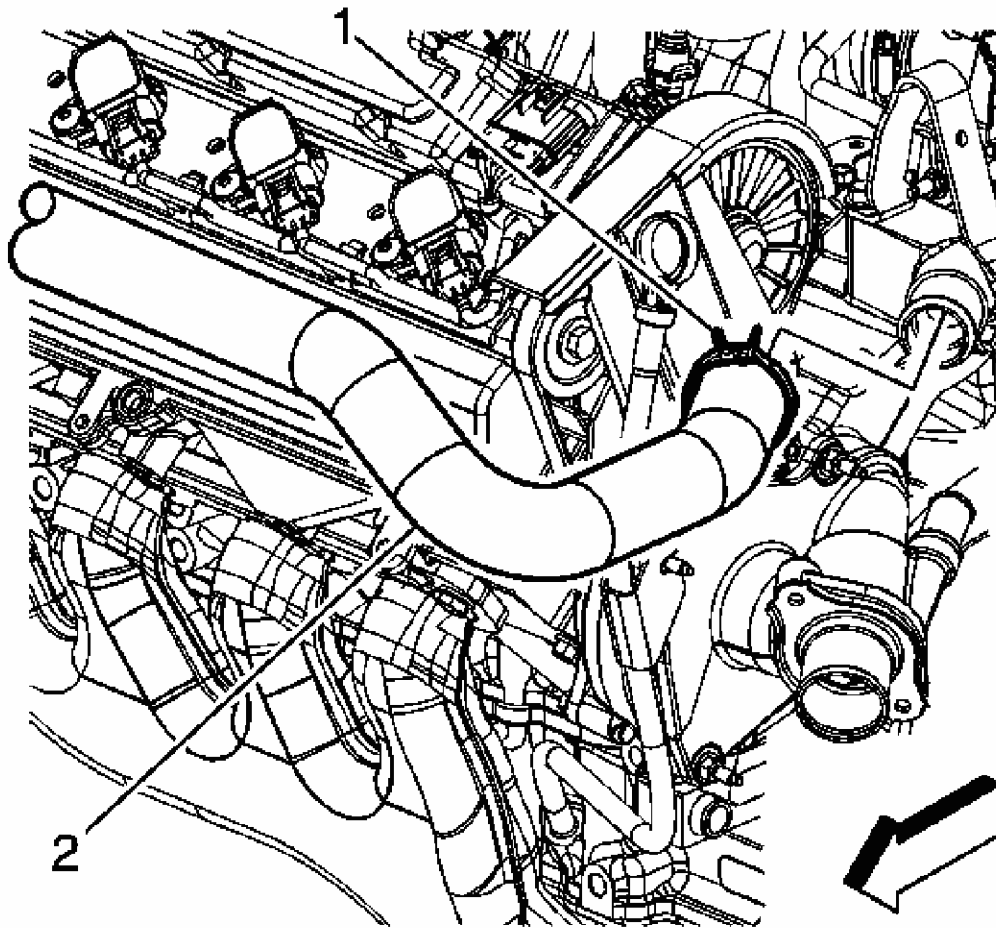


Fig. 144: View Of Radiator Inlet Hose & Clamp
Courtesy of GENERAL MOTORS CORP.

21. Install the radiator inlet hose (2) to the water pump housing.
22. Position the radiator inlet hose clamp (1).
23. Install the upper tie bar. Refer to **Front End Upper Tie Bar Replacement** .
24. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** or **Cooling System Draining and Filling (Vac-N-Fill)** .
25. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.

CAMSHAFT COVER REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

1. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.
2. Remove the secondary air injection (AIR) check valve. Refer to **Secondary Air Injection Check Valve Replacement**.

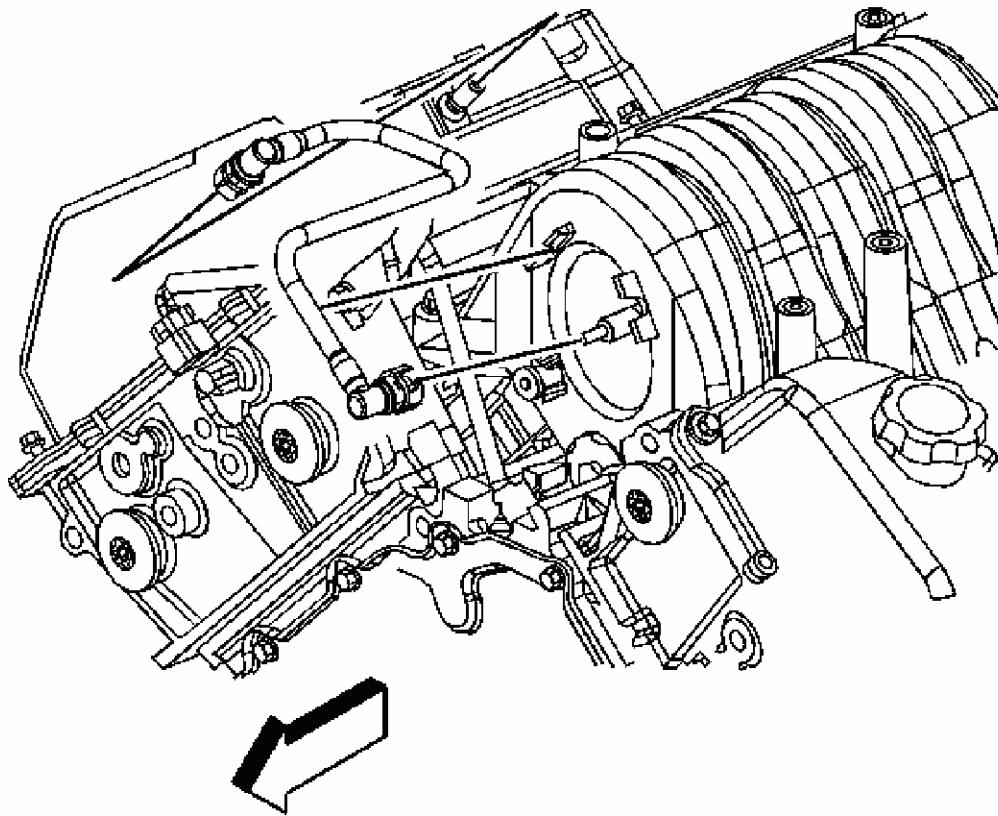


Fig. 145: Identifying PCV Foul Air Tube Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

3. Disconnect the positive crankcase ventilation (PCV) foul air tube quick connect fitting from the camshaft cover. Refer to **Plastic Collar Quick Connect Fitting Service**.
4. Remove the ignition coils. Refer to **Ignition Coil Replacement - Bank 1**.

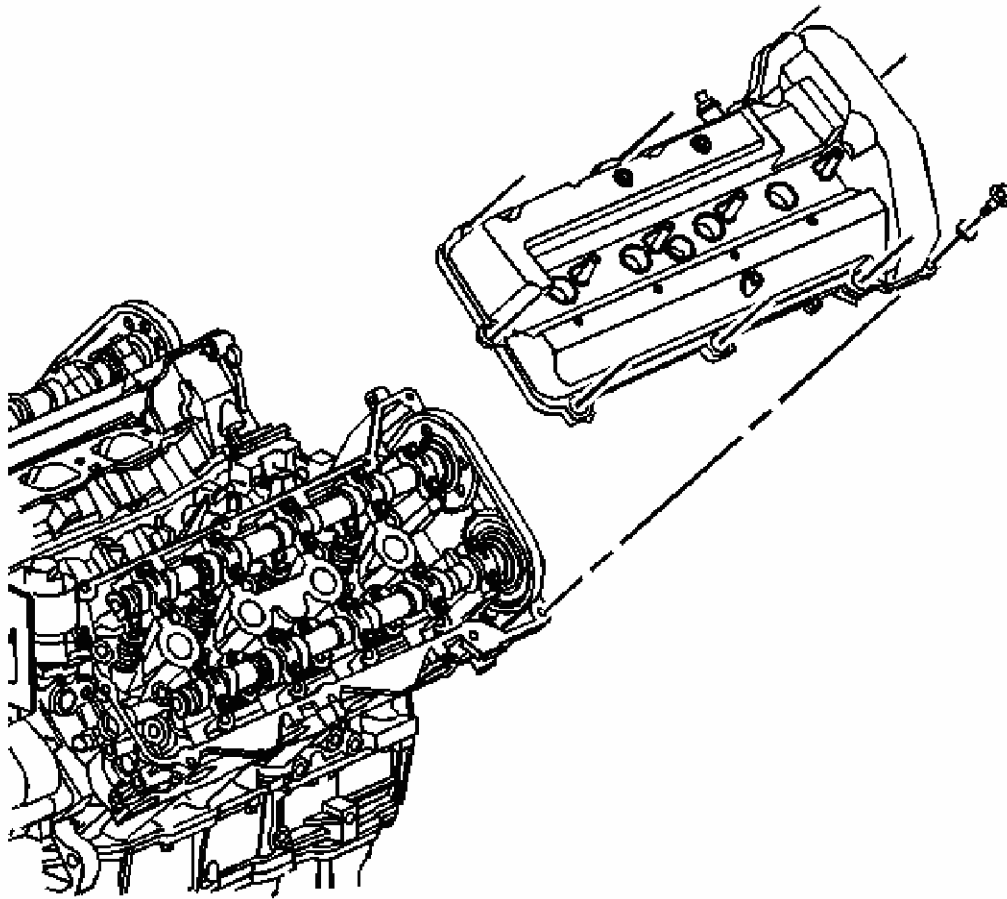


Fig. 146: View Of Camshaft Cover & Bolts
Courtesy of GENERAL MOTORS CORP.

5. Loosen the camshaft cover bolts.
6. Remove the camshaft cover.
7. Discard the camshaft cover perimeter seals and spark plug seals if there is any evidence of damage or if the seal comes out of the groove in the cover during removal.
8. Clean and inspect the camshaft cover. Refer to **Camshaft Cover Cleaning and Inspection** .

INSTALLATION PROCEDURE

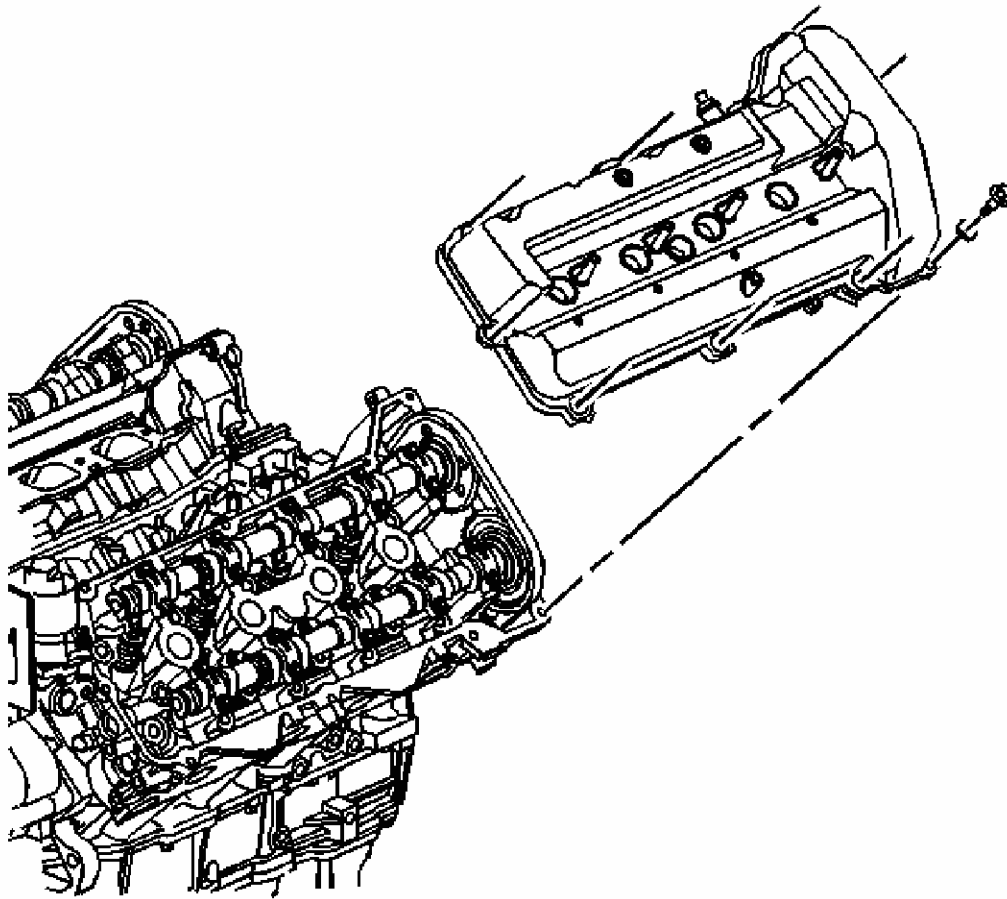


Fig. 147: View Of Camshaft Cover & Bolts
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Be careful to prevent the exposed section of the camshaft cover seal from being damaged by the edge of the cylinder head casting.

1. Install the camshaft cover seal as required.
2. Install the camshaft cover.

NOTE: Refer to Fastener Notice .

3. Tighten the camshaft cover bolts.

Tighten: Tighten the bolts to 10 N.m (89 lb in).

4. Install the ignition coils. Refer to **Ignition Coil Replacement - Bank 1** .

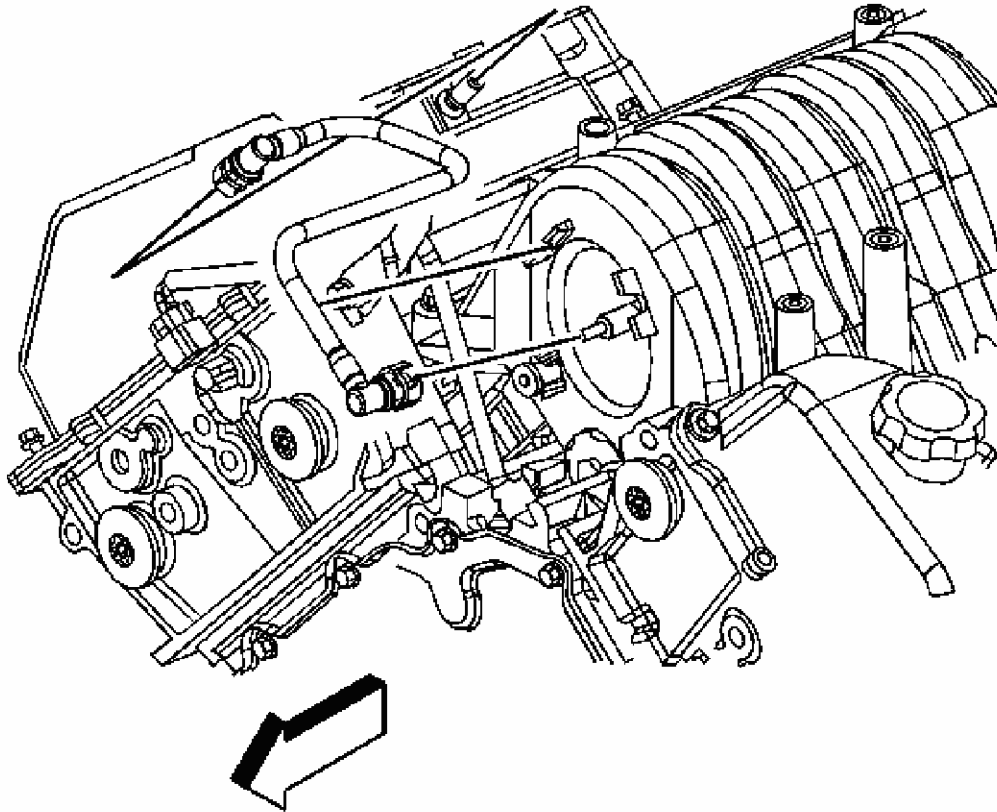


Fig. 148: Identifying PCV Foul Air Tube Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

5. Connect the PCV foul air tube quick connect fitting to the camshaft cover. Refer to **Plastic Collar Quick Connect Fitting Service** .
6. Install the AIR check valve. Refer to **Secondary Air Injection Check Valve Replacement** .
7. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.

SECONDARY CAMSHAFT DRIVE CHAIN REPLACEMENT - LEFT SIDE

TOOLS REQUIRED

J 44212 Camshaft Holding Tool. See **Special Tools** .

REMOVAL PROCEDURE

1. Remove the right secondary camshaft drive chain. Refer to **Secondary Camshaft Drive Chain Replacement - Right Side**.
2. Remove the left secondary drive chain tensioner. Refer to **Secondary Camshaft Drive Chain Tensioner Replacement - Left Side**.
3. Remove the left camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.

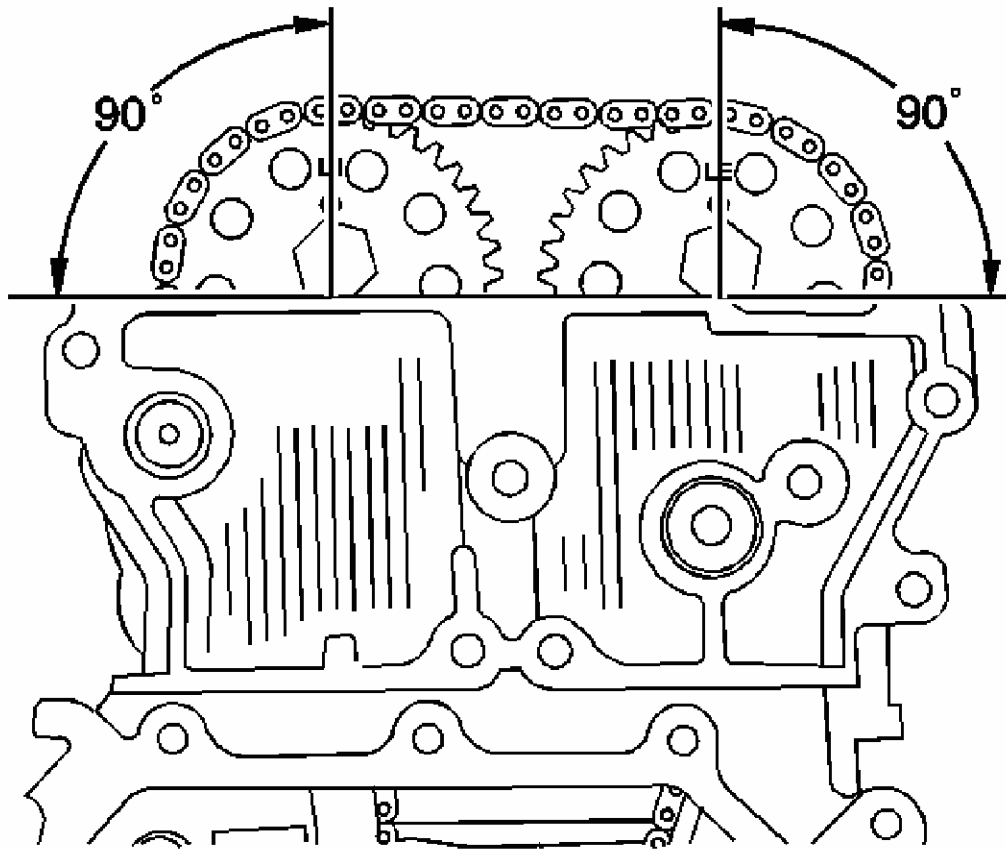


Fig. 149: Ensuring Camshaft Sprocket Drive Pins Are At The Top Of Their Rotation

Courtesy of GENERAL MOTORS CORP.

4. Ensure both camshaft sprocket drive pins are at the top of their rotation.

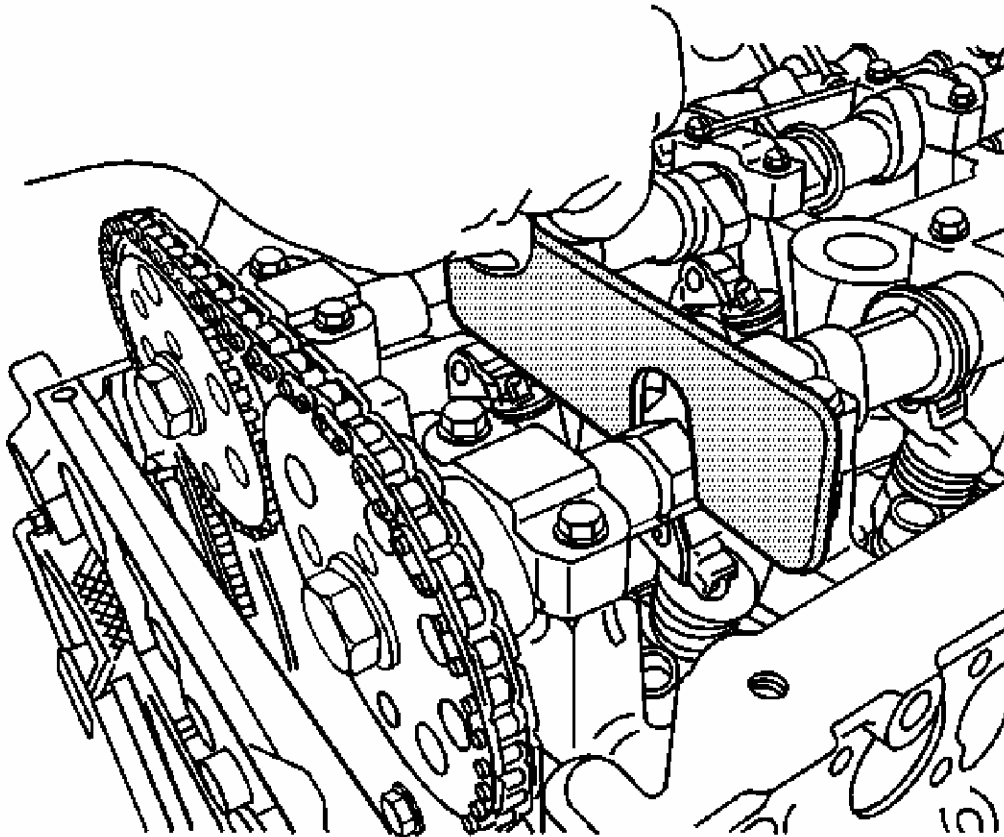


Fig. 150: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Camshaft Holding Tool Caution .

5. Install the **J 44212** over the camshafts. See Special Tools .

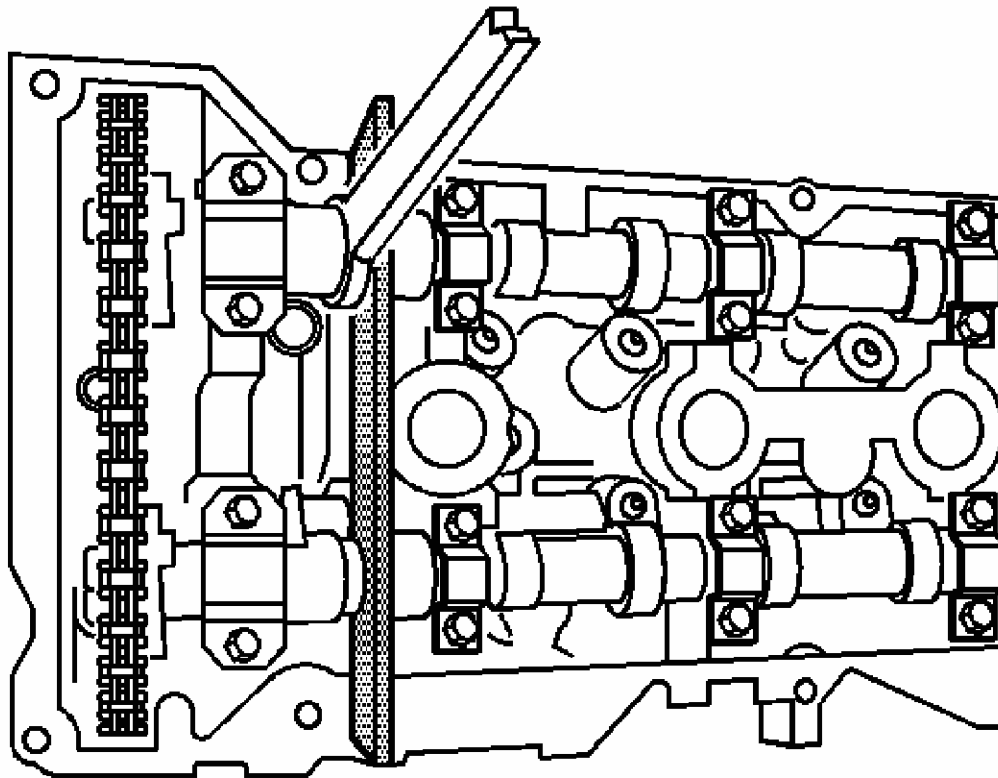


Fig. 151: Holding Camshaft
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Torque Reaction Against Timing Drive Chain Notice .

6. Use an open end wrench on the hex cast into the camshaft in order to prevent the camshaft from rotating when removing the camshaft sprocket bolt.

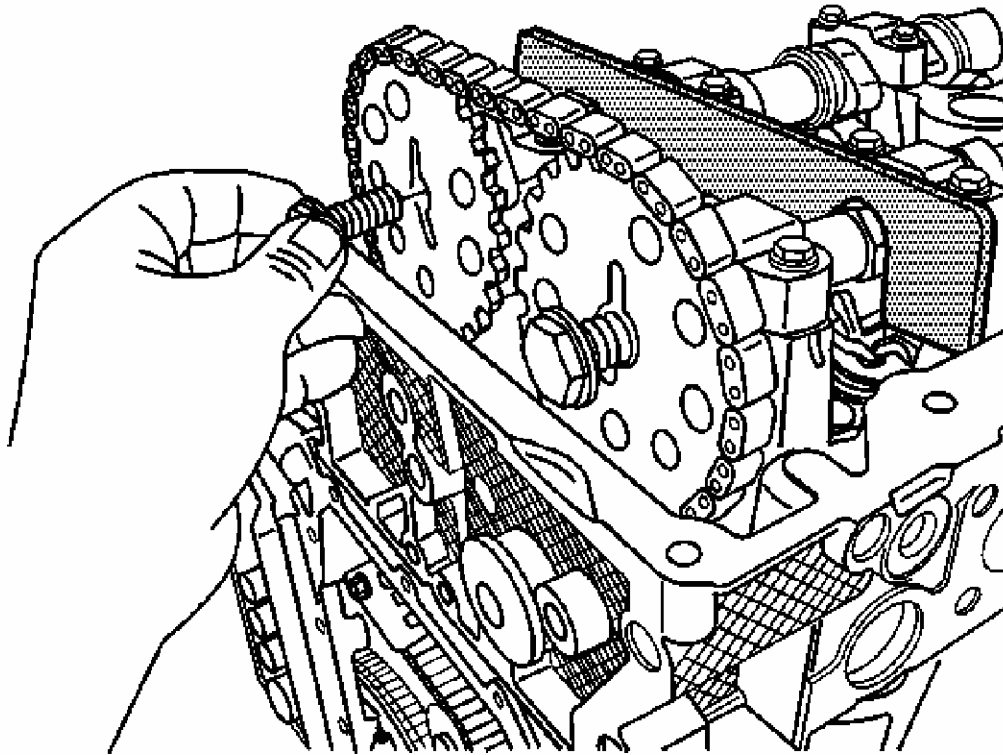


Fig. 152: Identifying Left Intake Camshaft Sprocket Bolt
Courtesy of GENERAL MOTORS CORP.

7. Remove the left intake camshaft sprocket bolt.
8. Slide the left intake camshaft sprocket off of the camshaft and remove the left secondary camshaft drive chain from the camshaft sprocket teeth.

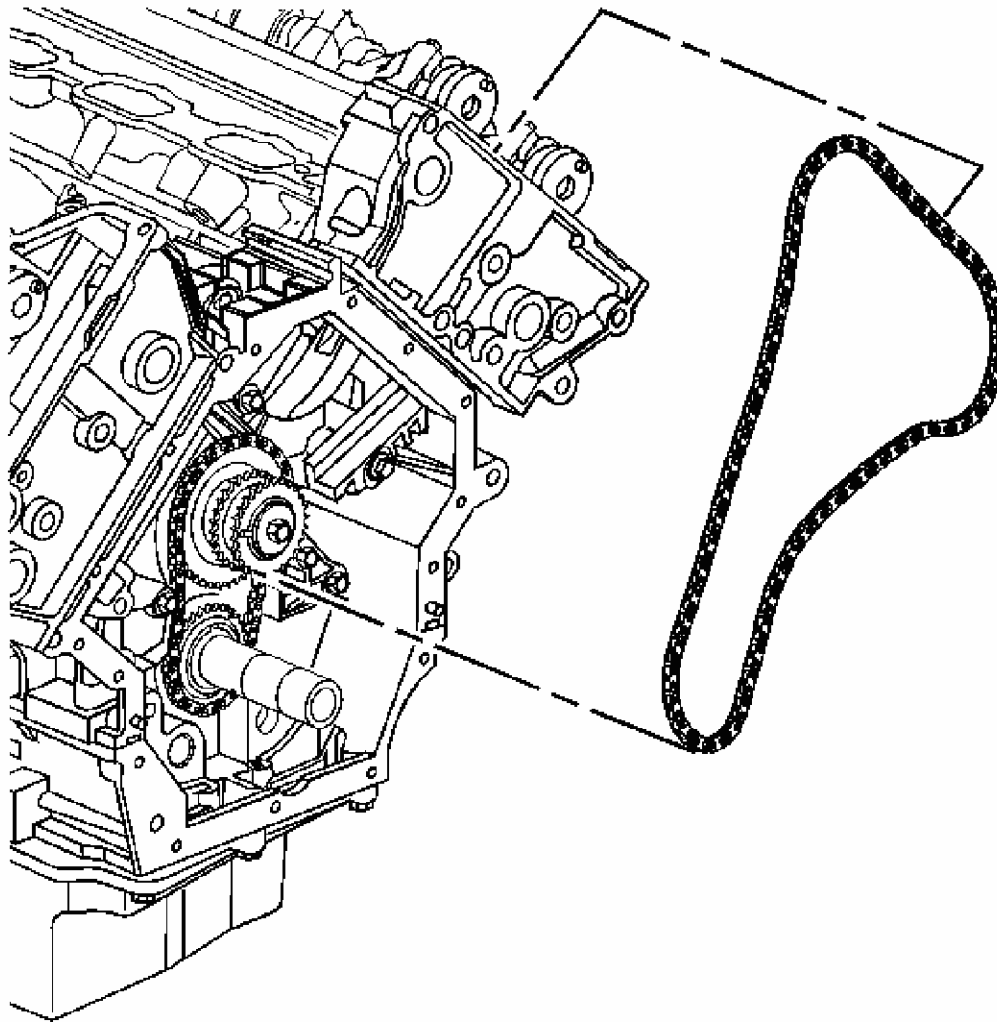


Fig. 153: View of Left Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS CORP.

9. Lift the left secondary camshaft drive chain from the camshaft intermediate drive shaft sprocket teeth.
10. Remove the left secondary camshaft drive chain from the engine.
11. Clean and inspect the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** .

INSTALLATION PROCEDURE

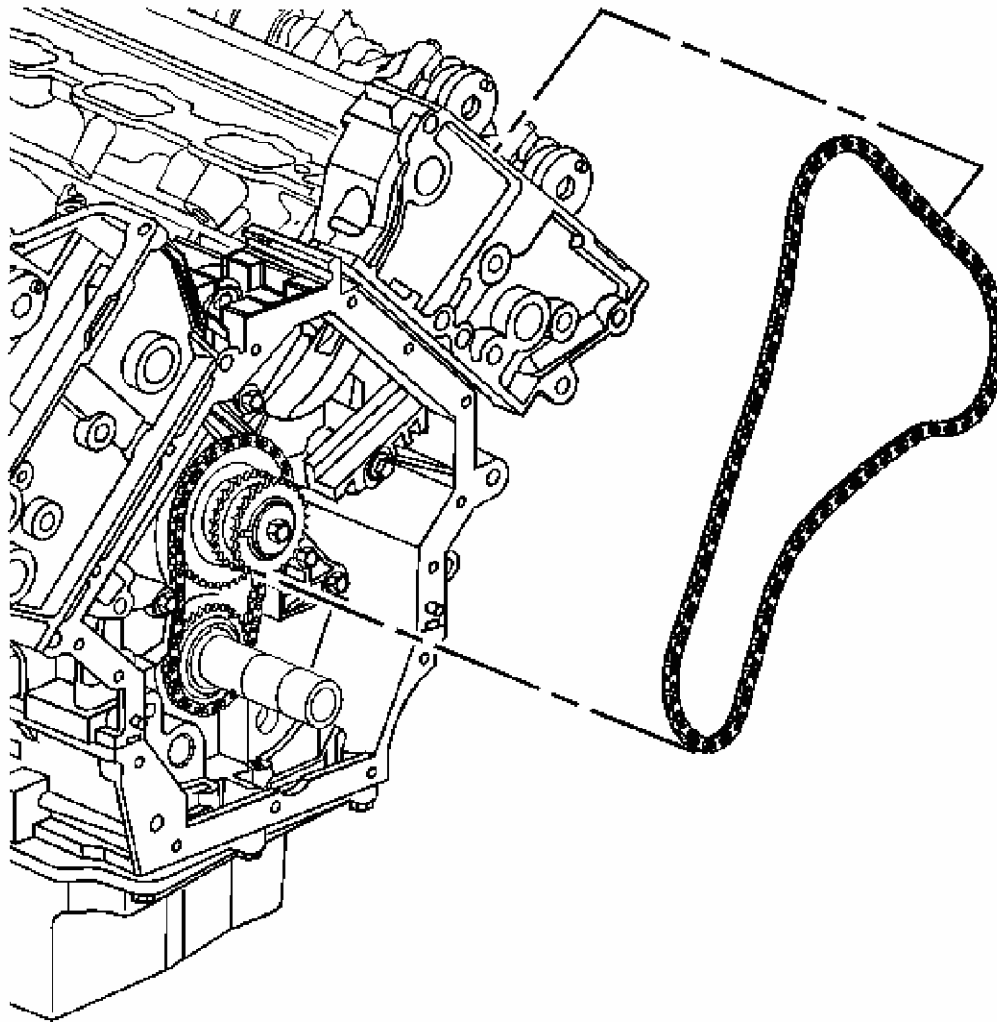


Fig. 154: View of Left Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS CORP.

1. Install the left secondary camshaft drive chain by sliding the chain down through the left cylinder head and placing the chain on the left exhaust camshaft sprocket.
2. Route the left secondary camshaft drive chain around the inner row of the camshaft intermediate drive shaft sprocket teeth.

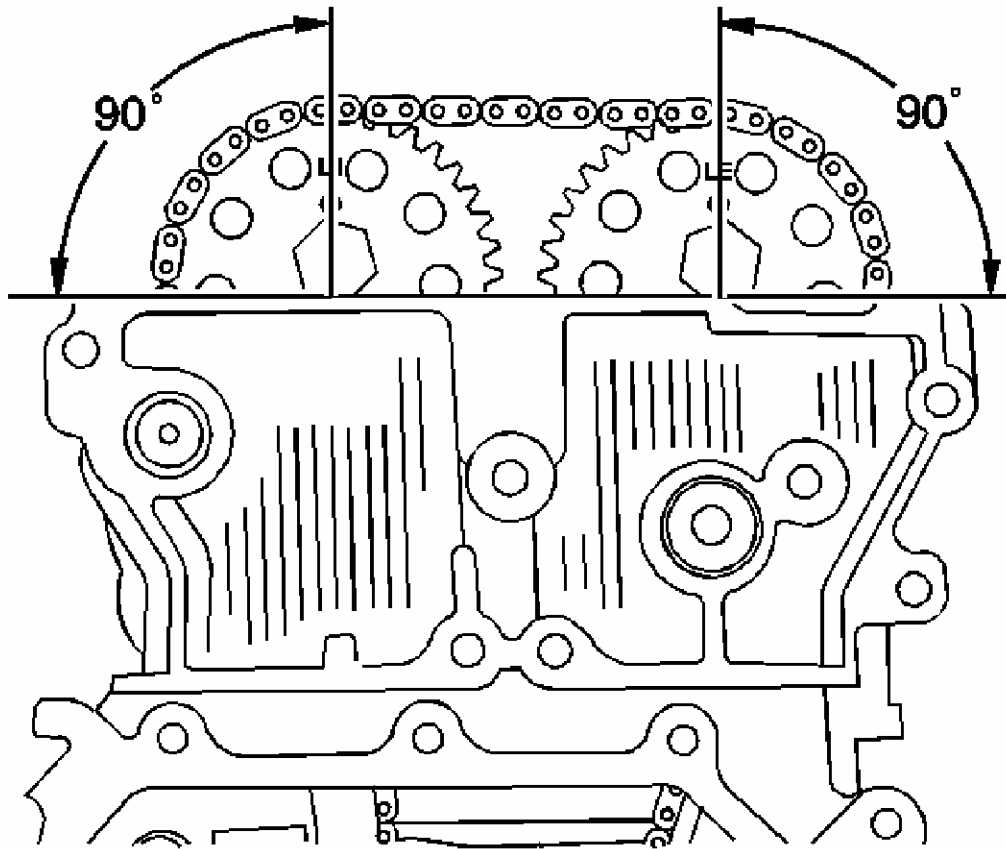


Fig. 155: Ensuring Camshaft Sprocket Drive Pins Are At The Top Of Their Rotation

Courtesy of GENERAL MOTORS CORP.

3. Install the left intake camshaft sprocket into the left secondary camshaft drive chain.
4. Install the left intake camshaft sprocket onto the camshaft. The camshaft sprocket notch marked LI (left intake) engages the intake camshaft pin.

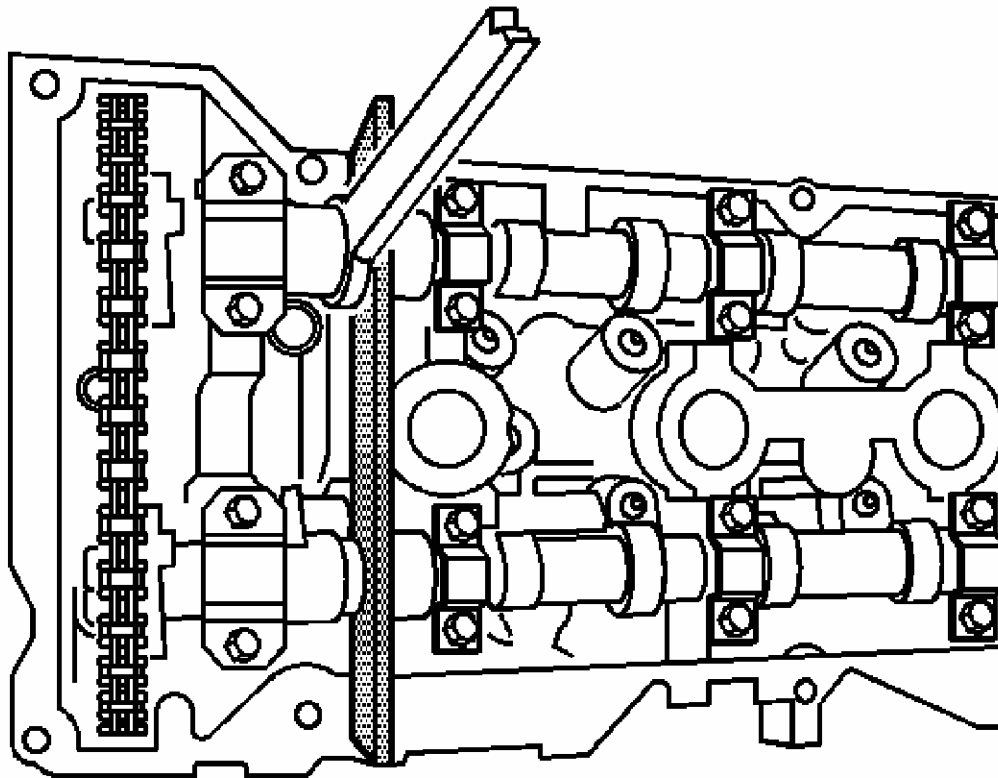


Fig. 156: Holding Camshaft
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Torque Reaction Against Timing Drive Chain Notice .

5. Use an open end wrench on the hex cast into the camshaft in order to prevent the camshaft from rotating when tightening the camshaft sprocket bolt.

NOTE: Refer to FASTENER NOTICE .

6. Install the left intake camshaft sprocket bolt.

Tighten: Tighten the camshaft sprocket bolt to 120 N.m (89 lb ft).

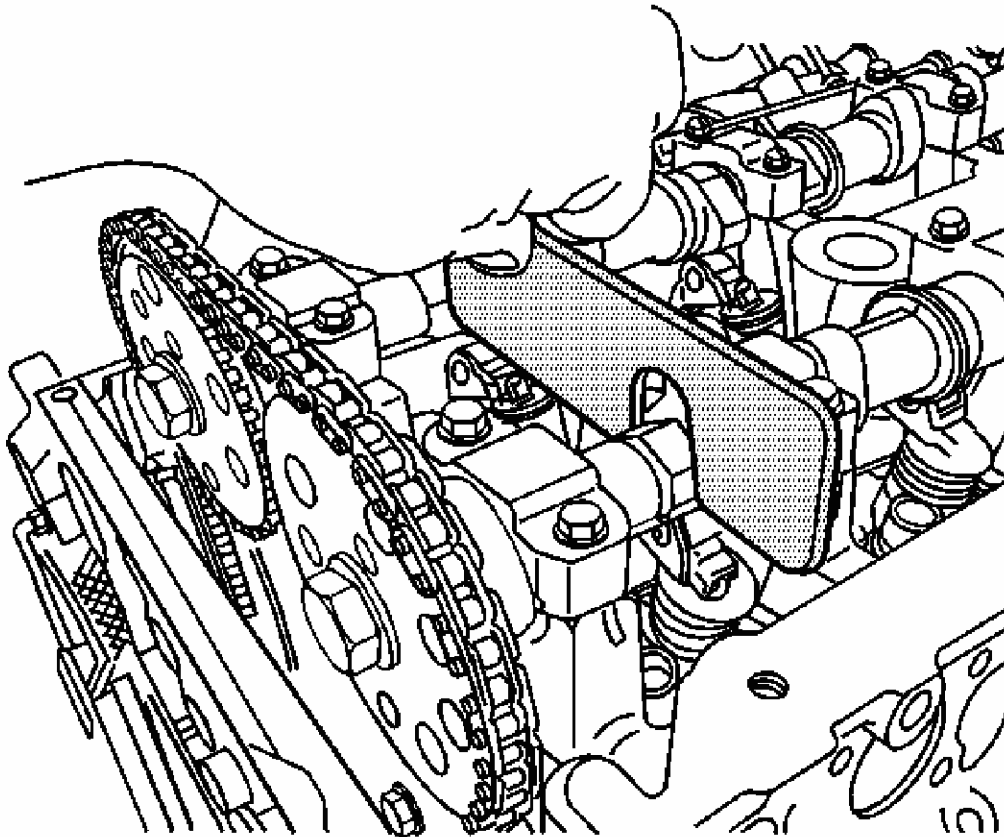


Fig. 157: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS CORP.

7. Remove the **J 44212** from the camshafts. See Special Tools .
8. Install the left camshaft cover. Refer to Camshaft Cover Replacement - Left Side.
9. Install the left secondary drive chain tensioner. Refer to Secondary Camshaft Drive Chain Tensioner Replacement - Left Side.
10. Install the right secondary camshaft drive chain. Refer to Secondary Camshaft Drive Chain Replacement - Right Side.

SECONDARY CAMSHAFT DRIVE CHAIN REPLACEMENT - RIGHT SIDE

TOOLS REQUIRED

J 44212 Camshaft Holding Tool. See Special Tools .

REMOVAL PROCEDURE

1. Remove the right secondary camshaft drive chain tensioner. Refer to **Secondary Camshaft Drive Chain Tensioner Replacement - Right Side**.
2. Remove the camshaft position (CMP) sensor. Refer to **Camshaft Position Sensor Replacement**.
3. Remove the right camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.

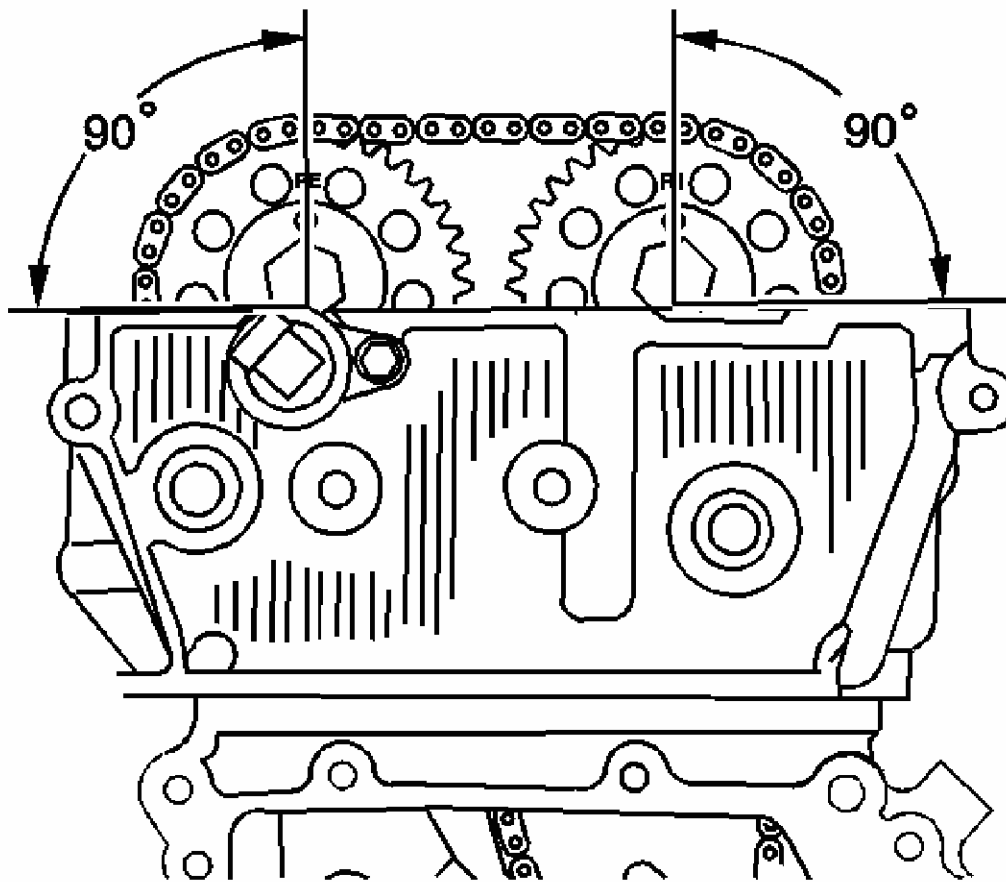


Fig. 158: Ensuring Camshaft Sprocket Drive Pins Are At Top Of Their Rotation
Courtesy of GENERAL MOTORS CORP.

4. Ensure both camshaft sprocket drive pins are at the top of their rotation.

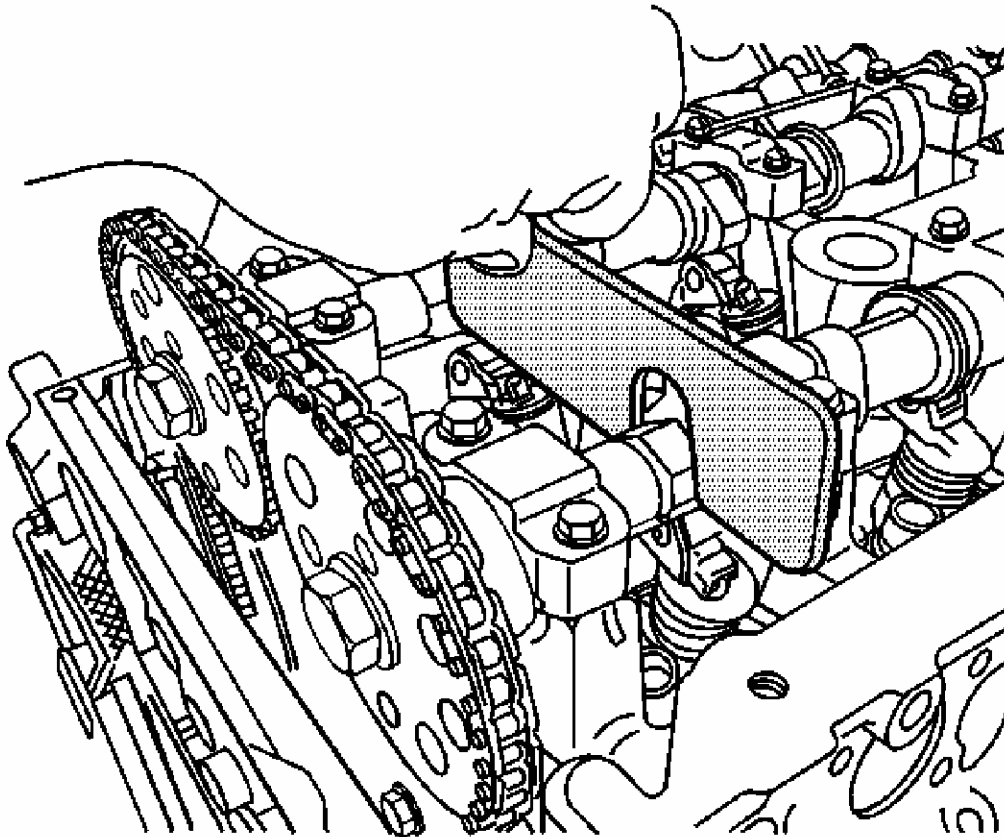


Fig. 159: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Camshaft Holding Tool Caution .

5. Install the **J 44212** over the camshafts. See Special Tools .

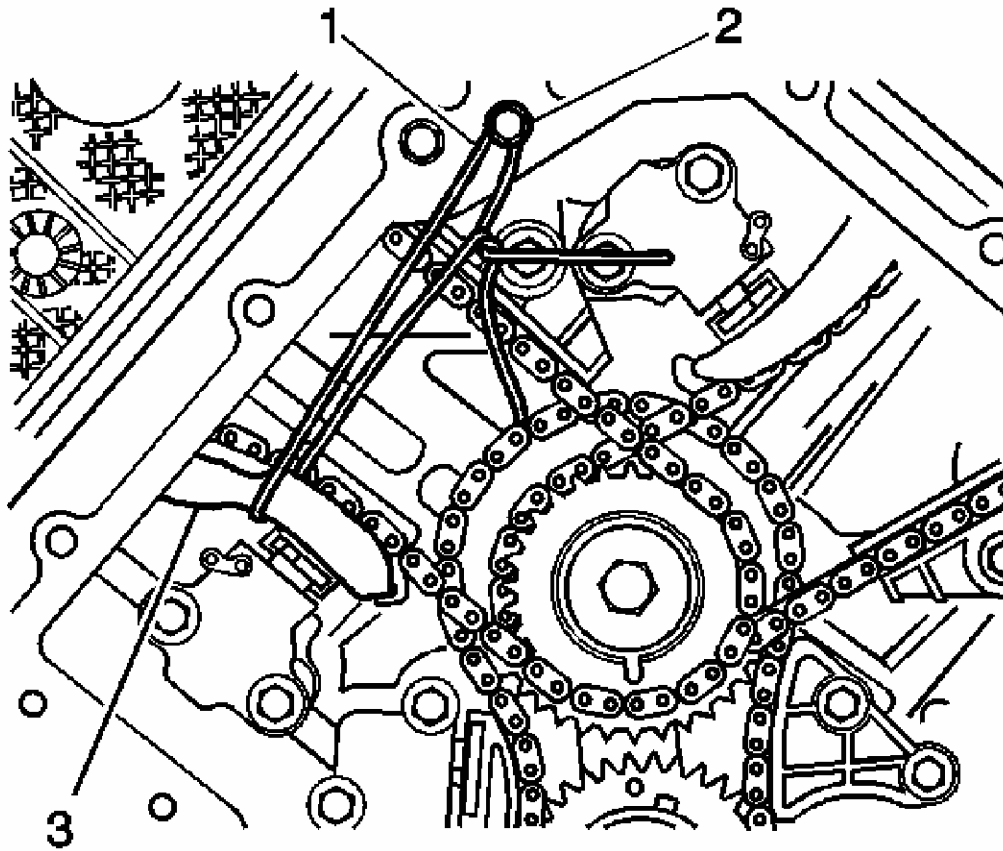


Fig. 160: View Of Mechanics Wire, Right Secondary Camshaft Drive Chain Shoe & Front Cover Bolt

Courtesy of GENERAL MOTORS CORP.

6. Remove the mechanics wire (1) supporting the right secondary camshaft drive chain shoe (3).
7. Remove the engine front cover bolt (2) from the front of the engine.

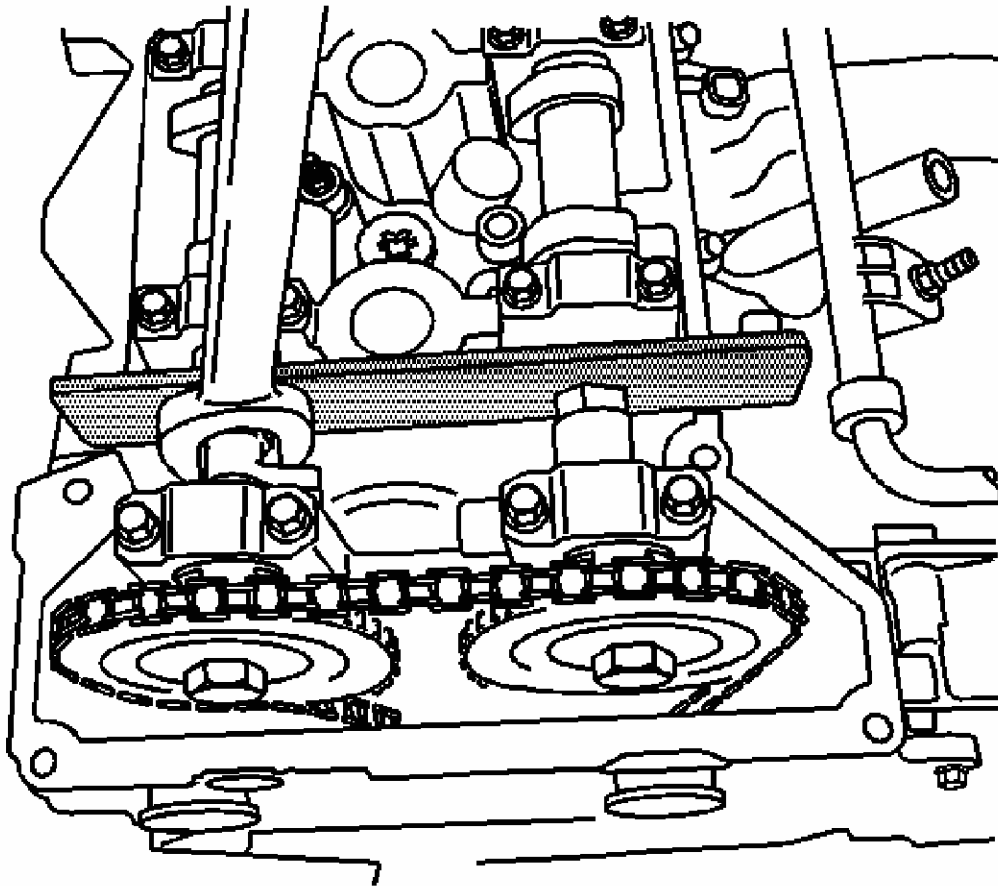


Fig. 161: Securing Camshaft Using An Open End Wrench
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Torque Reaction Against Timing Drive Chain Notice .

8. Use an open end wrench on the hex cast into the camshaft in order to prevent the camshaft from rotating when removing the camshaft sprocket bolt.

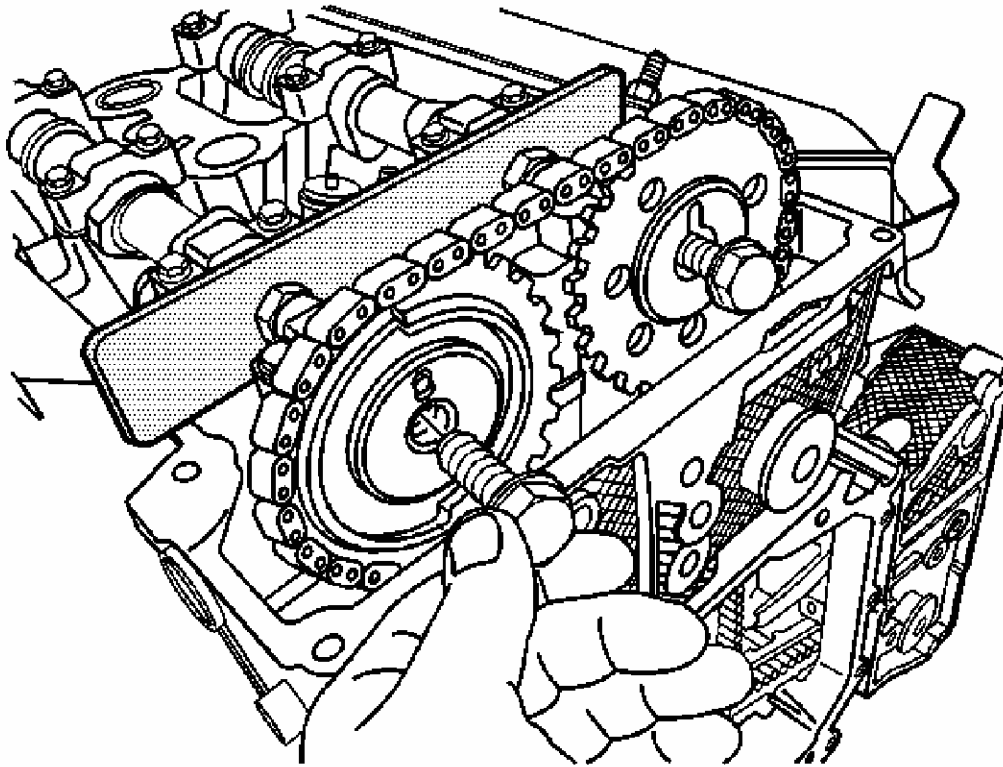


Fig. 162: Identifying Right Exhaust Camshaft Sprocket Bolt
Courtesy of GENERAL MOTORS CORP.

9. Remove the right exhaust camshaft sprocket bolt.
10. Slide the right exhaust camshaft sprocket off of the camshaft and remove the right secondary camshaft drive chain from the camshaft sprocket teeth.

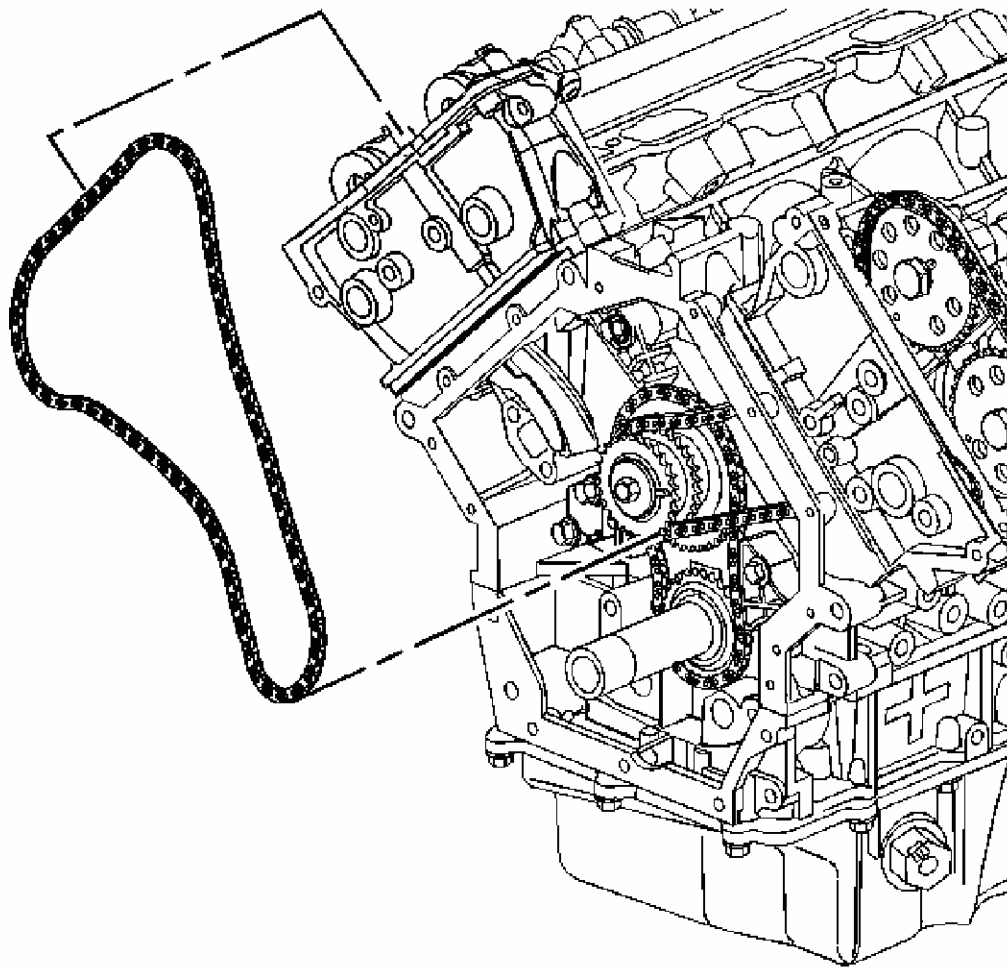


Fig. 163: View of Right Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS CORP.

11. Lift the right secondary camshaft drive chain from the camshaft intermediate drive shaft sprocket teeth.
12. Remove the right secondary camshaft drive chain from the engine.
13. Clean and inspect the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** .

INSTALLATION PROCEDURE

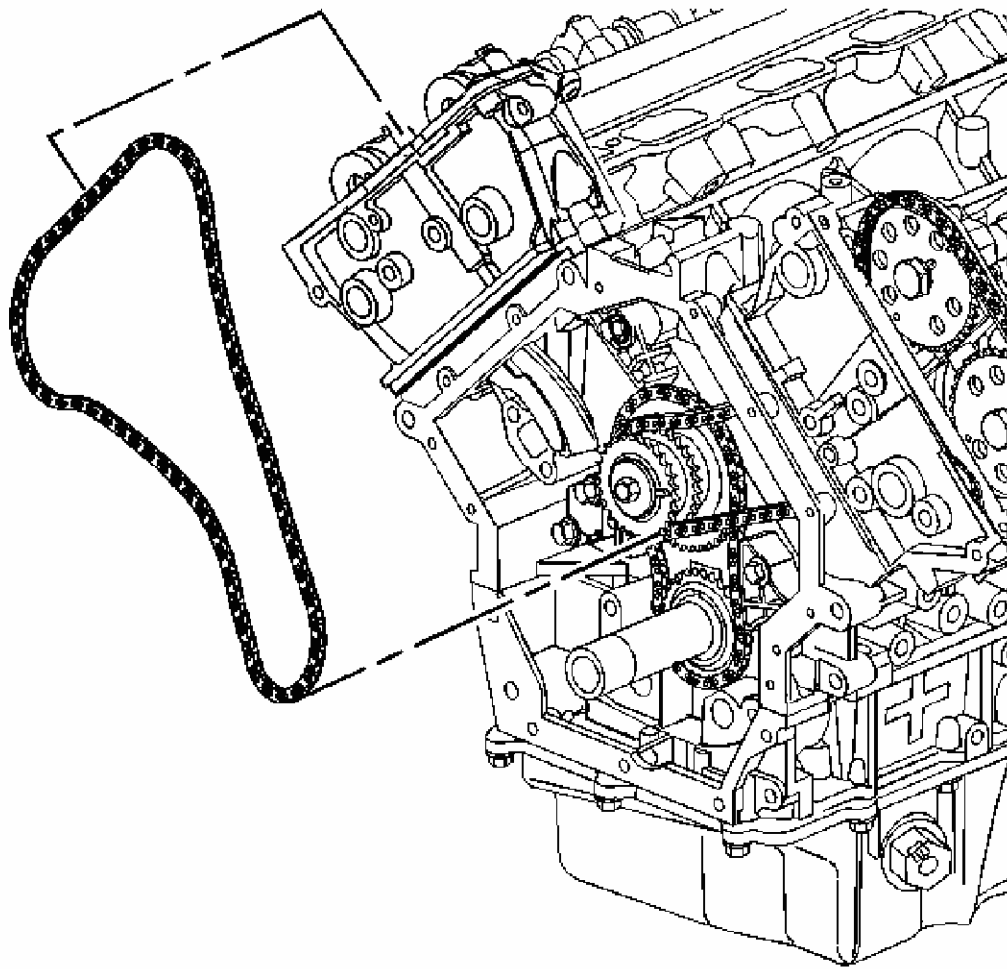


Fig. 164: View of Right Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS CORP.

1. Install the right secondary camshaft drive chain by sliding the chain down through the right cylinder head and placing the chain on the right intake camshaft sprocket.
2. Route the right secondary camshaft drive chain around the outer row of the camshaft intermediate drive shaft sprocket teeth.

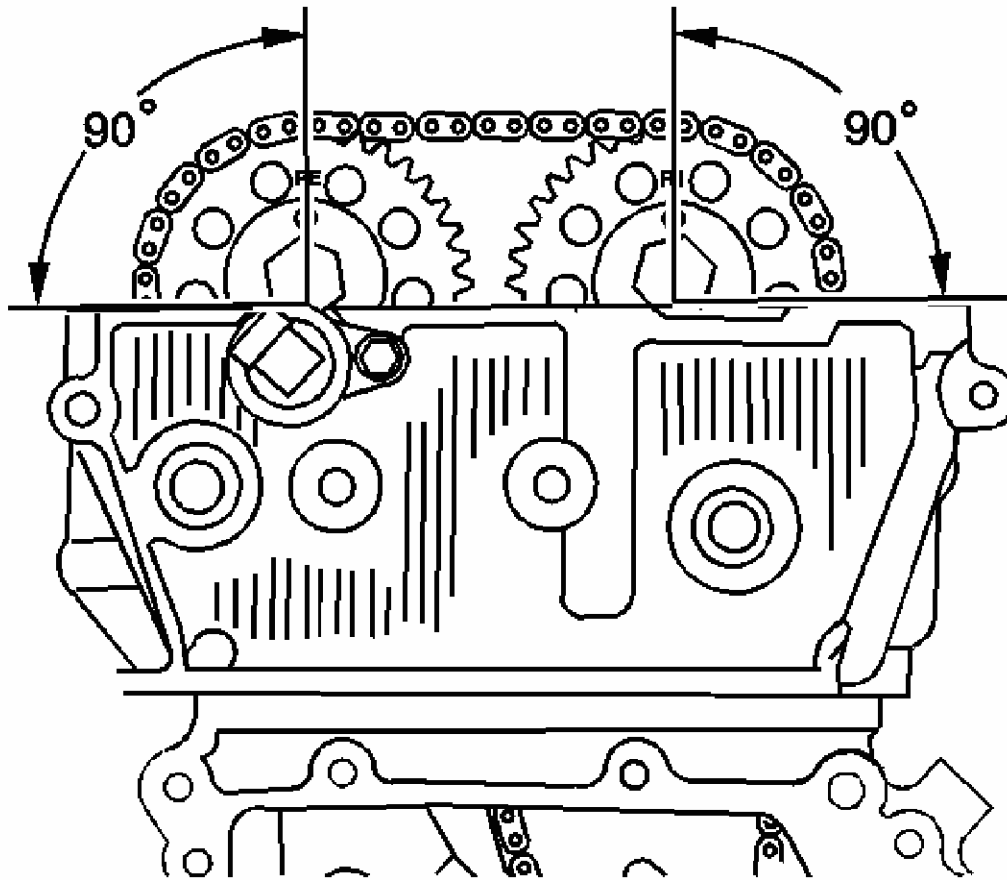


Fig. 165: Ensuring Camshaft Sprocket Drive Pins Are At Top Of Their Rotation
Courtesy of GENERAL MOTORS CORP.

3. Install the right exhaust camshaft sprocket into the right secondary camshaft drive chain.
4. Install the right exhaust camshaft sprocket onto the camshaft. The camshaft sprocket notch marked RE (right exhaust) engages the exhaust camshaft pin.

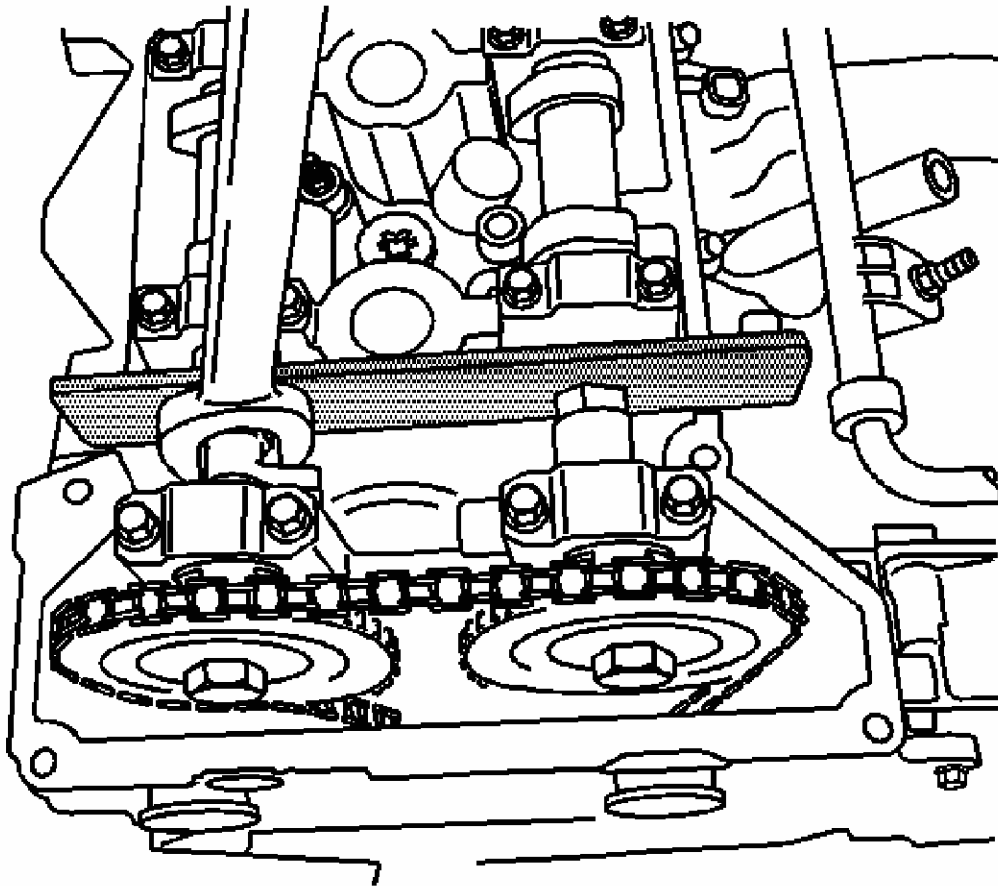


Fig. 166: Securing Camshaft Using An Open End Wrench
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Torque Reaction Against Timing Drive Chain Notice .

5. Use an open end wrench on the hex cast into the camshaft in order to prevent the camshaft from rotating when tightening the camshaft sprocket bolt.

NOTE: Refer to FASTENER NOTICE .

6. Install the right exhaust camshaft sprocket bolt.

Tighten: Tighten the camshaft sprocket bolt to 120 N.m (89 lb ft).

7. Install the right secondary camshaft drive chain tensioner. Refer to Secondary

Camshaft Drive Chain Tensioner Replacement - Right Side.

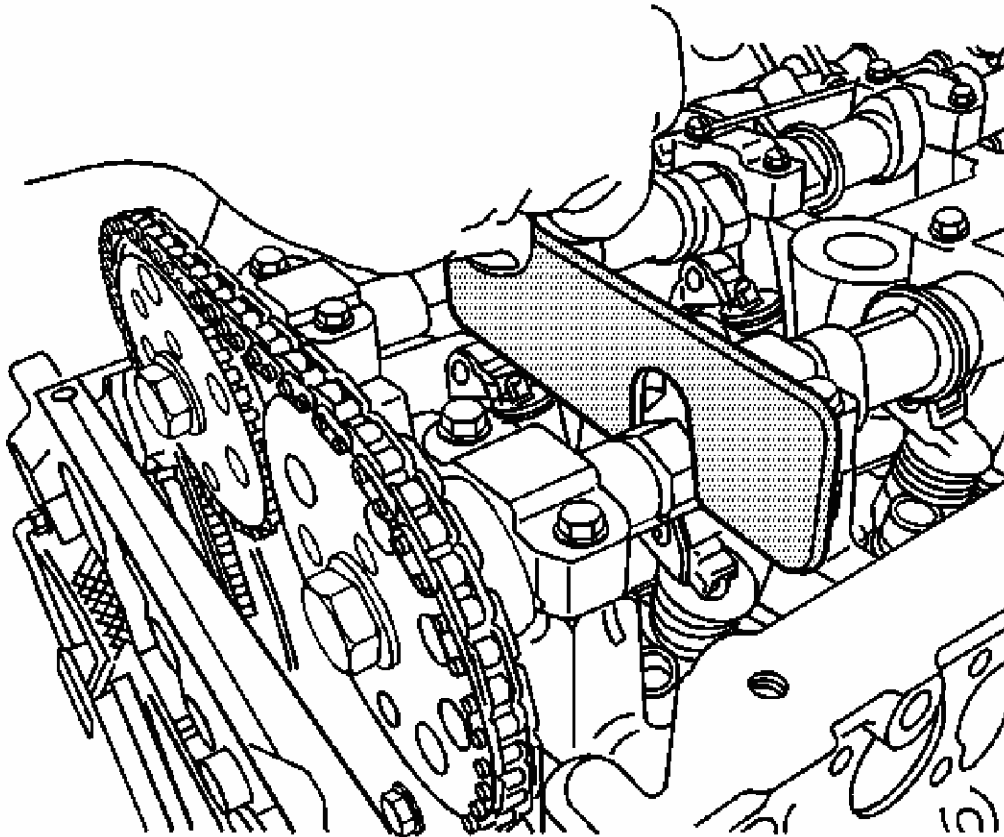


Fig. 167: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS CORP.

8. Remove the **J 44212** from the camshafts. See **Special Tools** .
9. Install the right camshaft cover. Refer to **Camshaft Cover Replacement - Right Side.**
10. Install the CMP sensor. Refer to **Camshaft Position Sensor Replacement** .

SECONDARY CAMSHAFT DRIVE CHAIN TENSIONER REPLACEMENT - LEFT SIDE

TOOLS REQUIRED

J 39946 Crankshaft Socket - 4. See **Special Tools** .0L and 4.6L

REMOVAL PROCEDURE

1. Remove the engine front cover. Refer to Engine Front Cover Replacement.

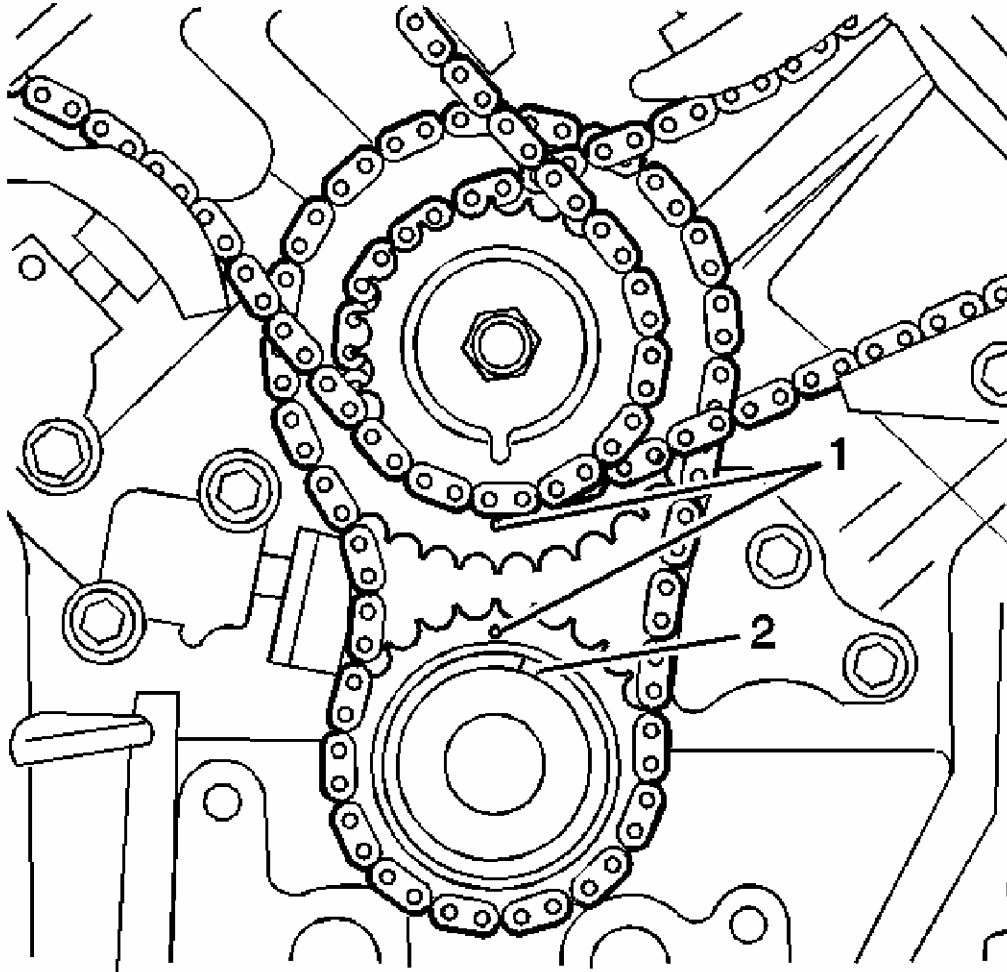


Fig. 168: Identifying Primary Timing Gear Alignment Marks
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Aligning the primary timing marks will locate the left camshafts in a neutral position, preventing them from rotating when the tensioner is removed.

2. Align the primary timing marks (1) using the J 39946 . See Special Tools .

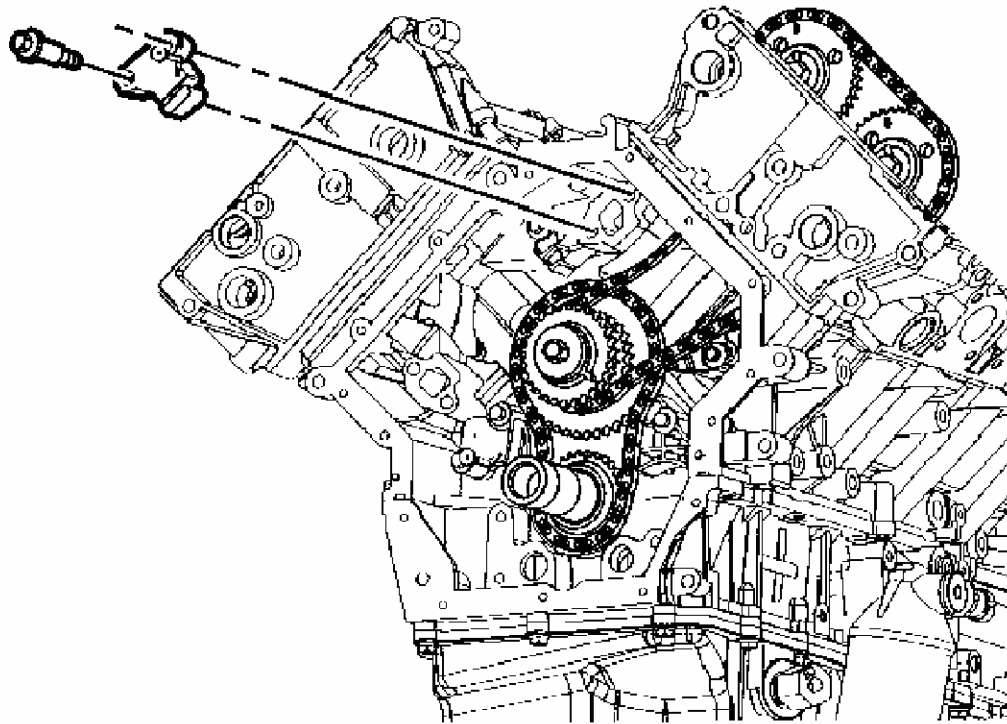


Fig. 169: View Of Left Secondary Camshaft Drive Chain Tensioner & Bolts
Courtesy of GENERAL MOTORS CORP.

3. Remove the 2 bolts attaching the left secondary camshaft drive chain tensioner to the engine block.
4. Remove the left secondary camshaft drive chain tensioner, allowing the tensioner to expand as you remove it.
5. Clean and inspect the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** .

INSTALLATION PROCEDURE

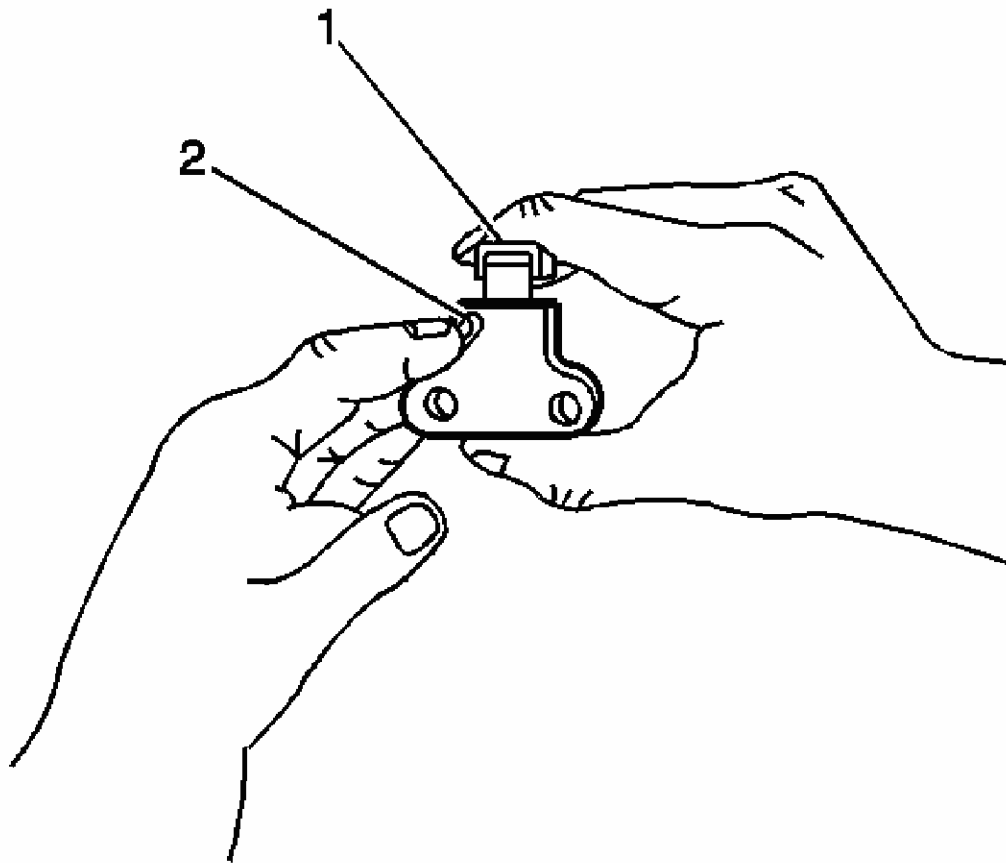


Fig. 170: View Of Tensioner Shoe & Ratchet Lever
Courtesy of GENERAL MOTORS CORP.

1. Collapse the left secondary camshaft chain tensioner using the following procedure:
 1. Rotate the ratchet release lever (2) counterclockwise and hold.
 2. Collapse the tensioner shoe (1) and hold.
 3. Release the ratchet lever (2).
2. Slowly release the pressure on the shoe (1), until the ratchet lever (2) moves to the first detent and a "click" is heard and felt.
3. Collapse the tensioner shoe (1) and hold.

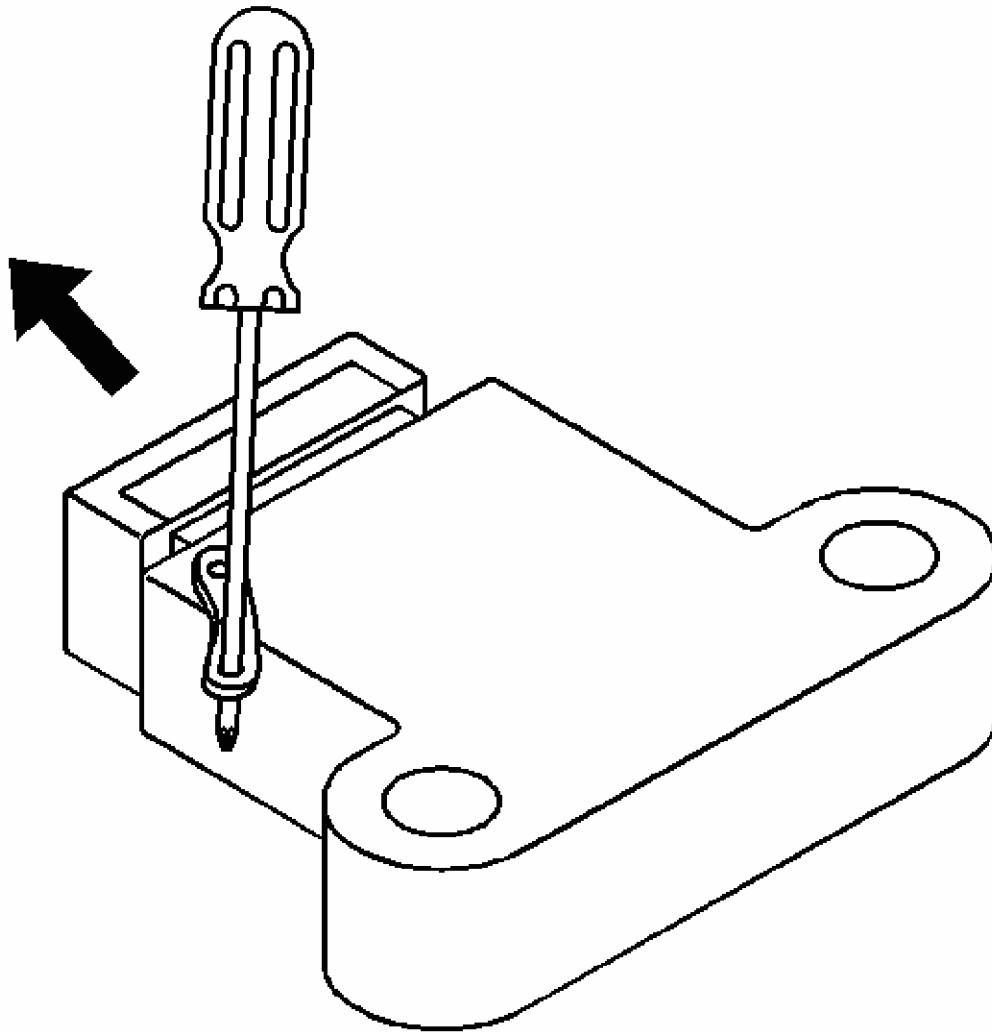


Fig. 171: Locking Tensioner Shoe In Collapsed Position
Courtesy of GENERAL MOTORS CORP.

4. Insert a pin through the hole in the release lever in order to lock the tensioner shoe in the collapsed position.

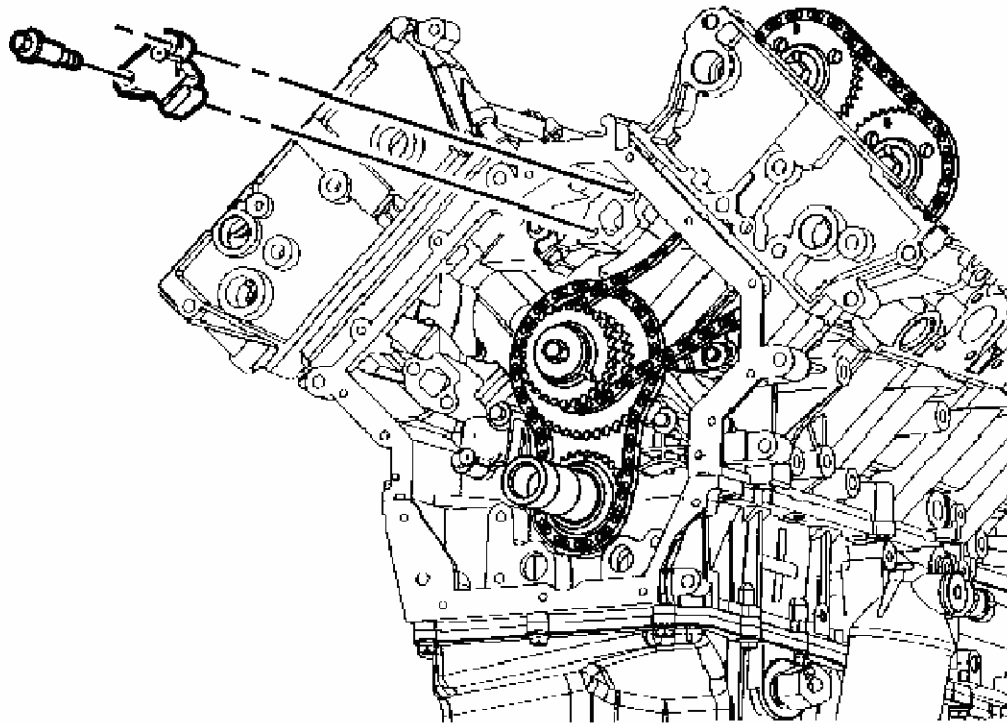


Fig. 172: View Of Left Secondary Camshaft Drive Chain Tensioner & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE .

IMPORTANT: Ensure the tensioner release lever is facing outward.

5. Install the left secondary camshaft drive chain tensioner and retaining bolts.

Tighten: Tighten the secondary camshaft drive chain tensioner bolts to 25 N.m (18 lb ft).

6. Remove the pin holding the tensioner to tighten any slack in the timing chain.
7. Install the engine front cover. Refer to Engine Front Cover Replacement.

SECONDARY CAMSHAFT DRIVE CHAIN TENSIONER REPLACEMENT - RIGHT SIDE

TOOLS REQUIRED

J 39946 Crankshaft Socket - 4. See **Special Tools** .0L and 4.6L

REMOVAL PROCEDURE

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.

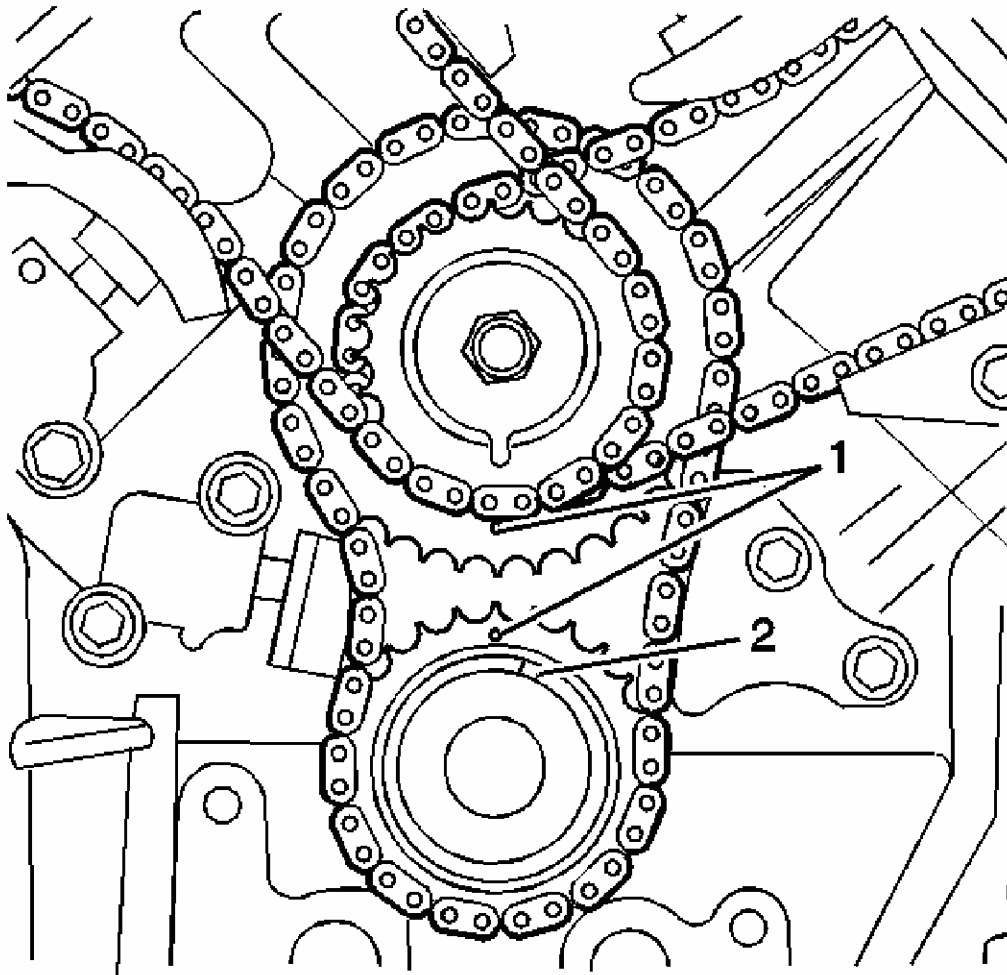


Fig. 173: Identifying Primary Timing Gear Alignment Marks
Courtesy of GENERAL MOTORS CORP.

2. Align the primary timing marks (1) using the **J 39946** . See **Special Tools** .

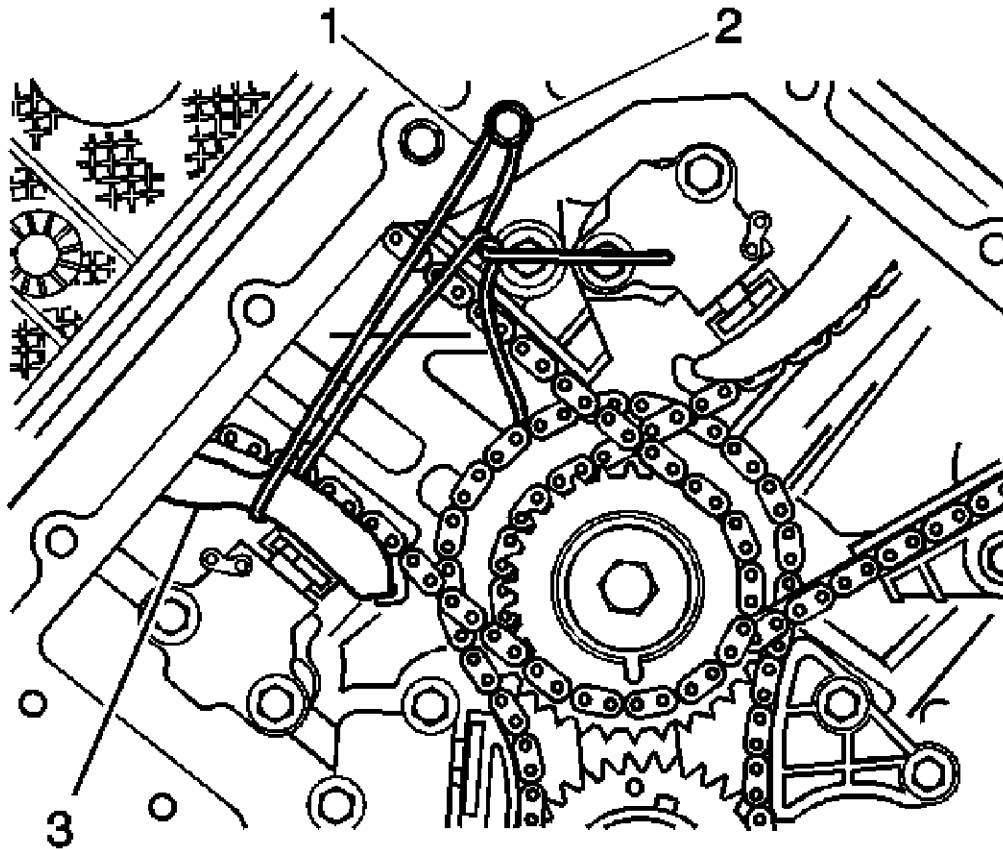


Fig. 174: View Of Mechanics Wire, Right Secondary Camshaft Drive Chain Shoe & Front Cover Bolt

Courtesy of GENERAL MOTORS CORP.

3. Install an engine front cover bolt (2) into the front of the engine.

IMPORTANT: Securing the right secondary camshaft drive chain shoe will prevent the right camshaft drive sprocket teeth from skipping on the right secondary timing chain.

4. Wrap mechanics wire (1) tightly around both the right secondary camshaft drive chain shoe (3) and the front cover bolt (2).

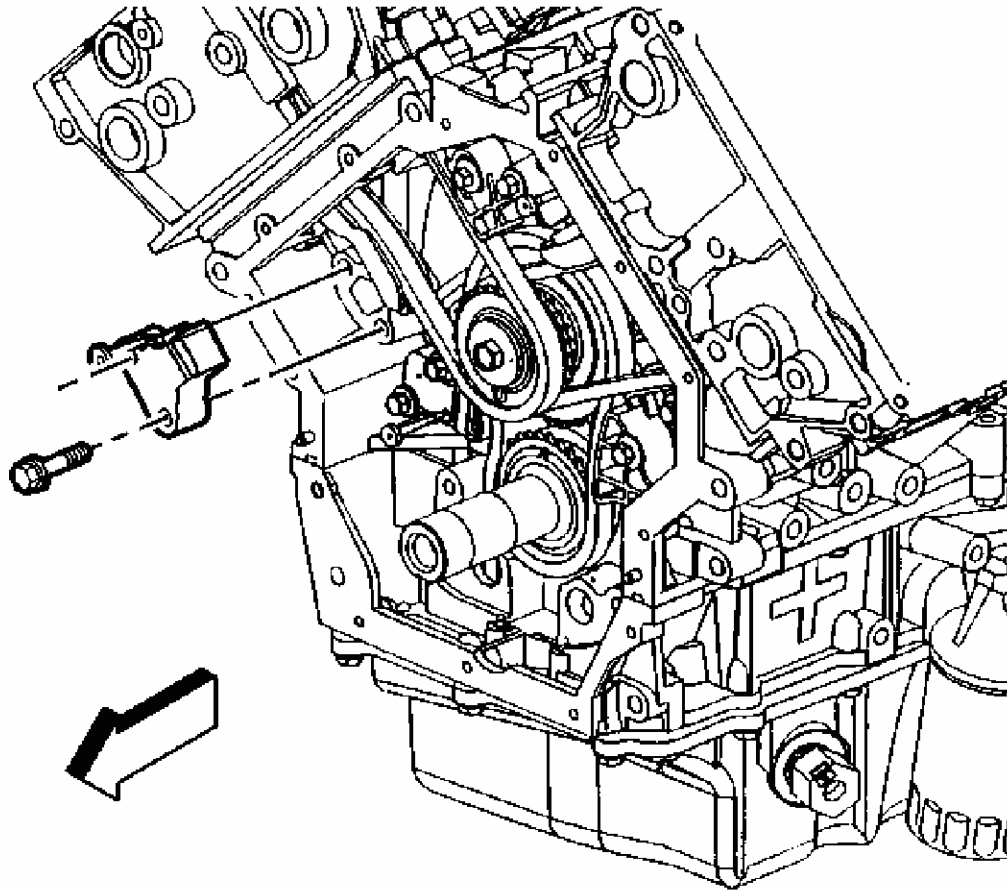


Fig. 175: View Of Right Secondary Camshaft Drive Chain Tensioner & Bolts
Courtesy of GENERAL MOTORS CORP.

5. Remove the 2 bolts attaching the right secondary camshaft drive chain tensioner to the engine block.
6. Remove the right secondary camshaft drive chain tensioner, allowing the tensioner to expand as you remove it.
7. Clean and inspect the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** .

INSTALLATION PROCEDURE

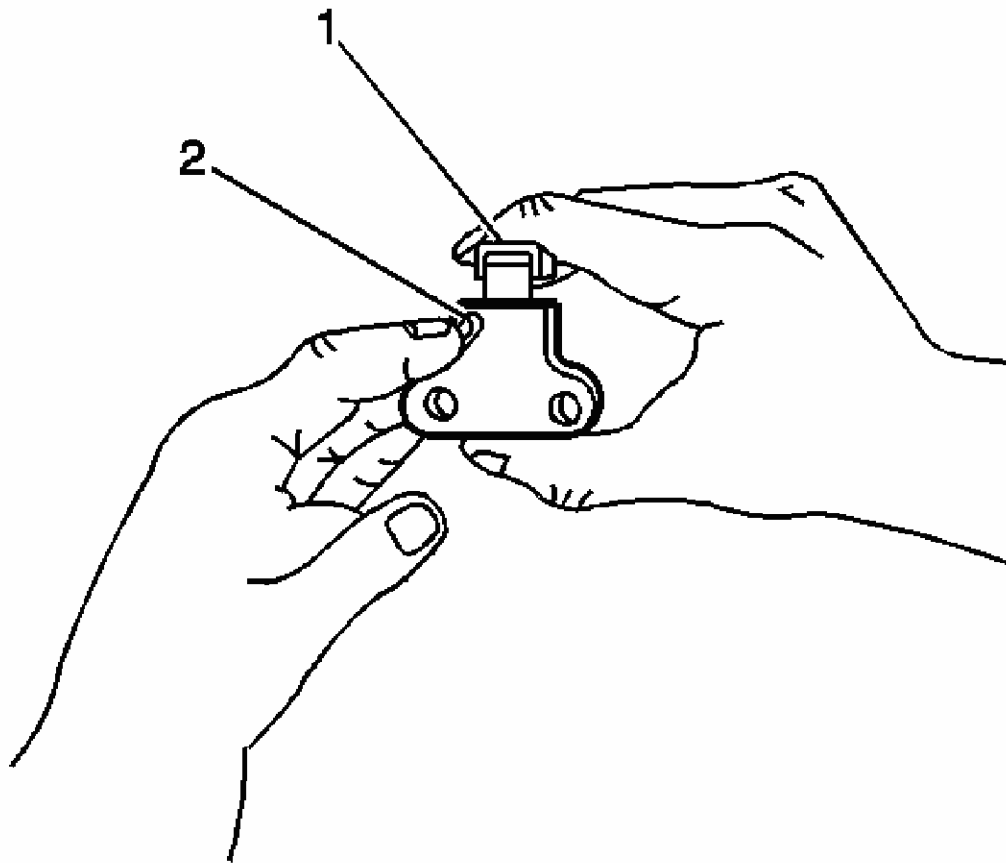


Fig. 176: View Of Tensioner Shoe & Ratchet Lever
Courtesy of GENERAL MOTORS CORP.

1. Collapse the right secondary camshaft chain tensioner using the following procedure:
 1. Rotate the ratchet release lever (2) counterclockwise and hold.
 2. Collapse the tensioner shoe (1) and hold.
 3. Release the ratchet lever (2).
2. Slowly release the pressure on the shoe (1), until the ratchet lever (2) moves to the first detent and a "click" is heard and felt.
3. Collapse the tensioner shoe (1) and hold.

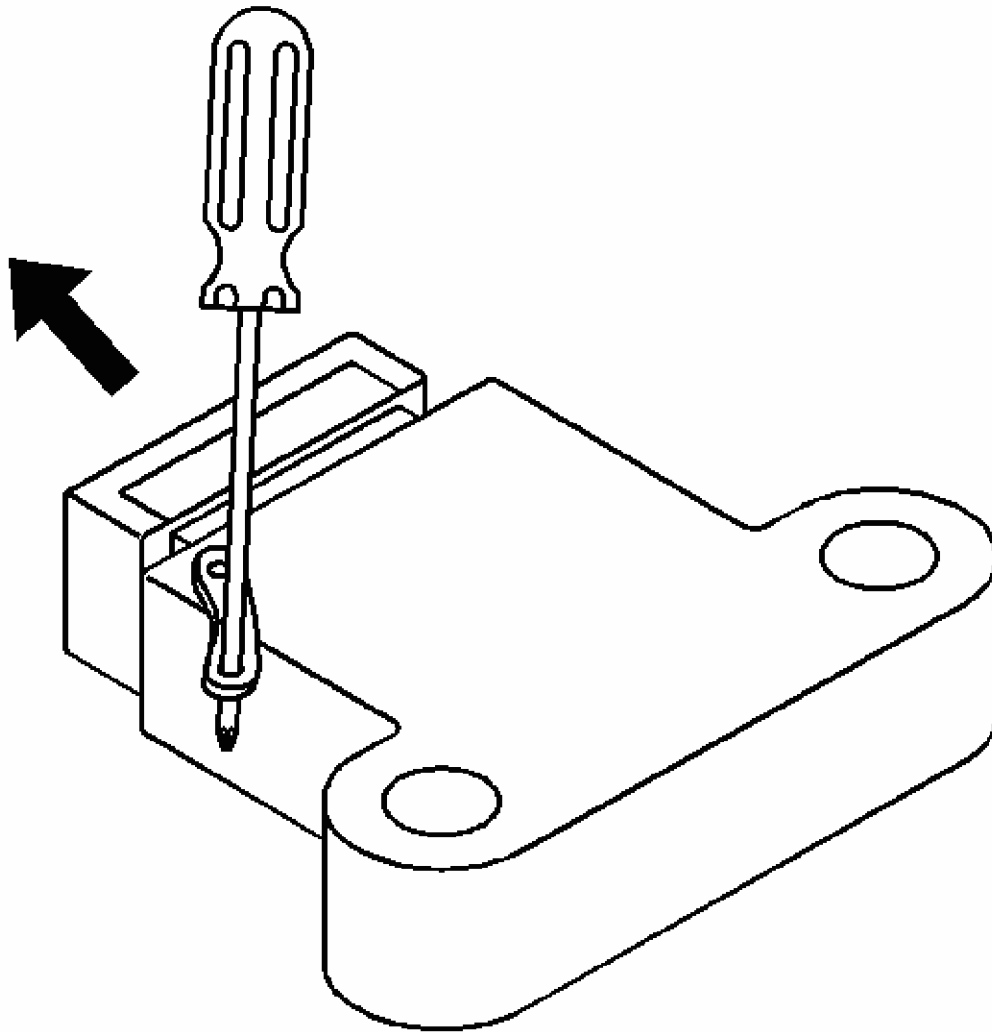


Fig. 177: Locking Tensioner Shoe In Collapsed Position
Courtesy of GENERAL MOTORS CORP.

4. Insert a pin through the hole in the release lever in order to lock the tensioner shoe in the collapsed position.

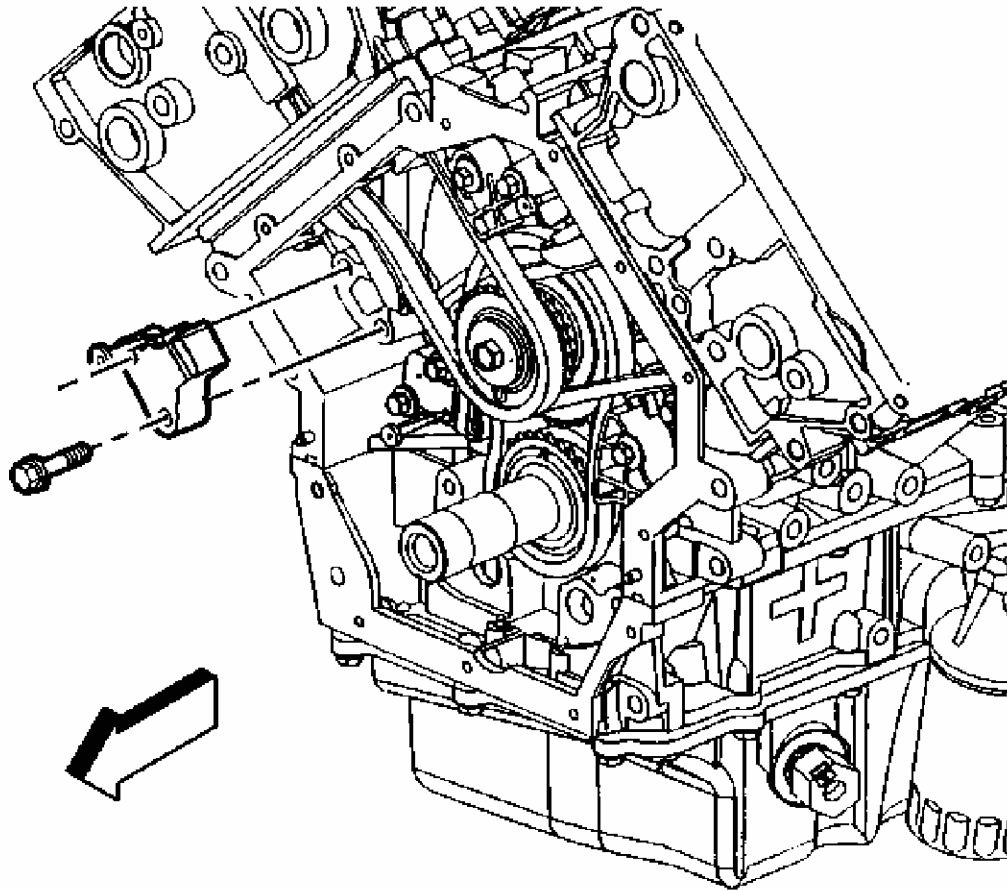


Fig. 178: View Of Right Secondary Camshaft Drive Chain Tensioner & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE .

IMPORTANT: Ensure the tensioner release lever is facing outward.

5. Install the right secondary camshaft drive chain tensioner and retaining bolts.

Tighten: Tighten the secondary camshaft drive chain tensioner bolts to 25 N.m (18 lb ft).

6. Remove the pin holding the tensioner to tighten any slack in the timing chain.

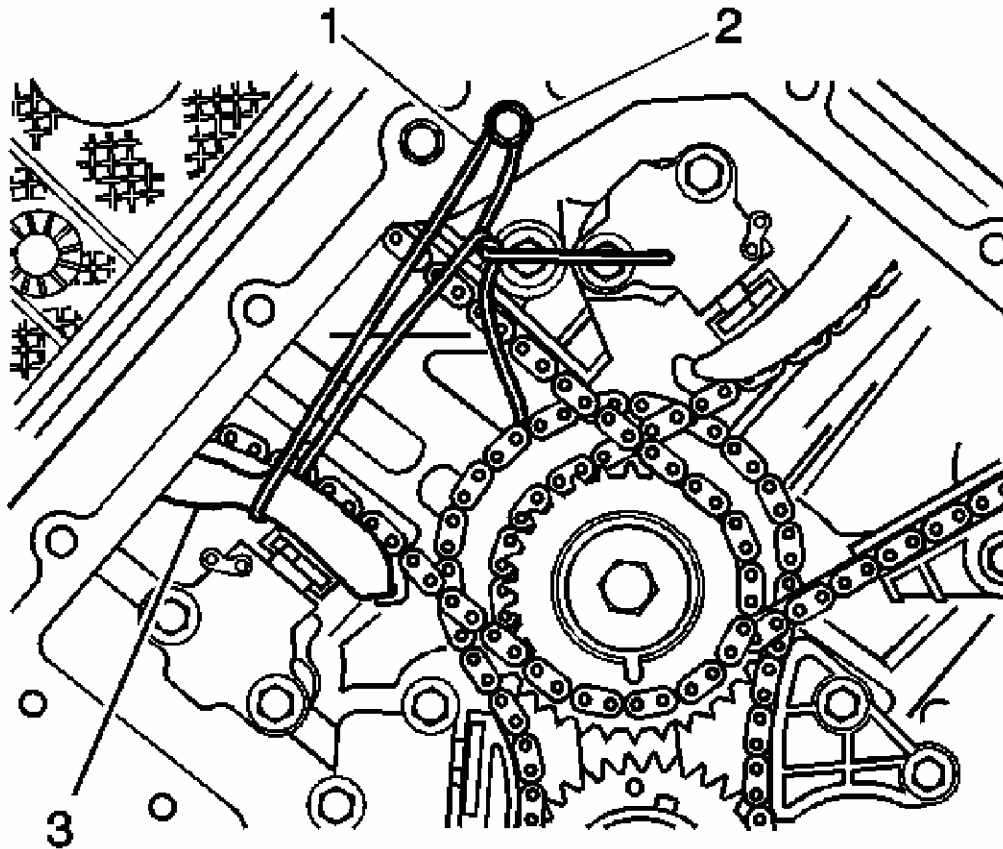


Fig. 179: View Of Mechanics Wire, Right Secondary Camshaft Drive Chain Shoe & Front Cover Bolt

Courtesy of GENERAL MOTORS CORP.

7. Remove the mechanics wire (1) supporting the right secondary camshaft drive chain shoe (3).
8. Remove the engine front cover bolt (2) from the front of the engine.
9. Install the engine front cover. Refer to Engine Front Cover Replacement.

SECONDARY CAMSHAFT DRIVE CHAIN SHOE REPLACEMENT - LEFT SIDE

TOOLS REQUIRED

J 44212 Camshaft Holding Tool. See Special Tools .

REMOVAL PROCEDURE

1. Remove the left secondary camshaft drive chain tensioner. Refer to **Secondary Camshaft Drive Chain Tensioner Replacement - Left Side**.
2. Remove the left camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.

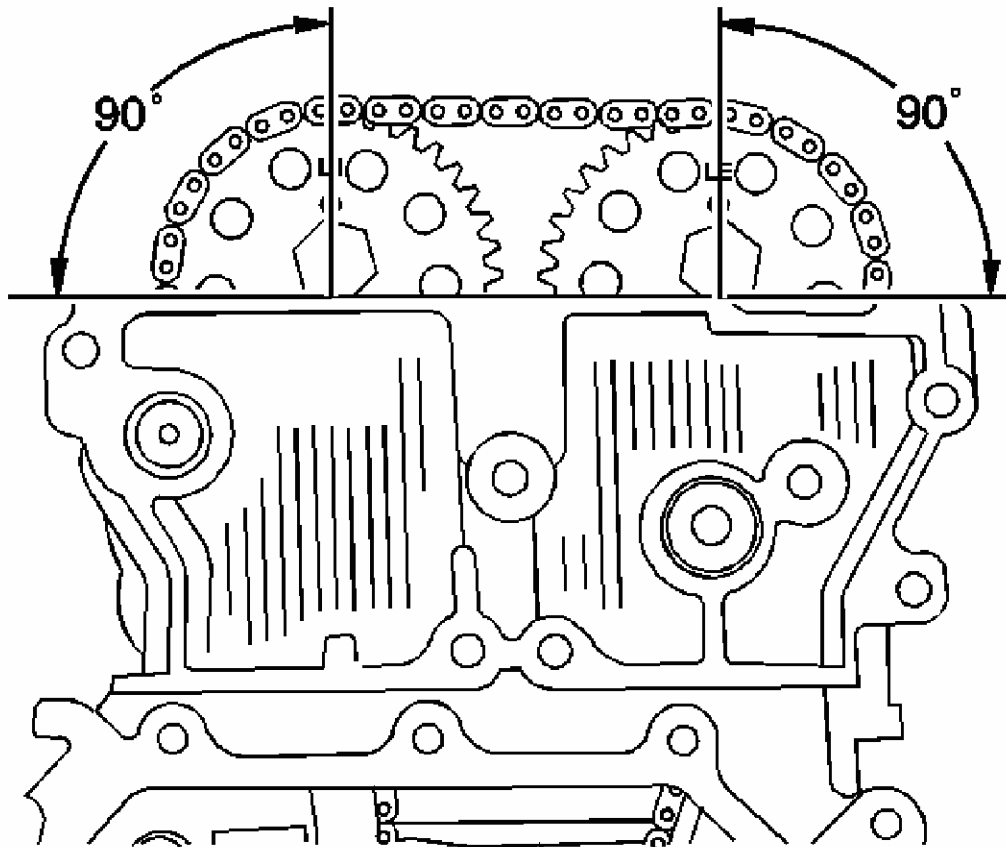


Fig. 180: Ensuring Camshaft Sprocket Drive Pins Are At The Top Of Their Rotation

Courtesy of GENERAL MOTORS CORP.

3. Ensure both camshaft sprocket drive pins are at the top of their rotation.

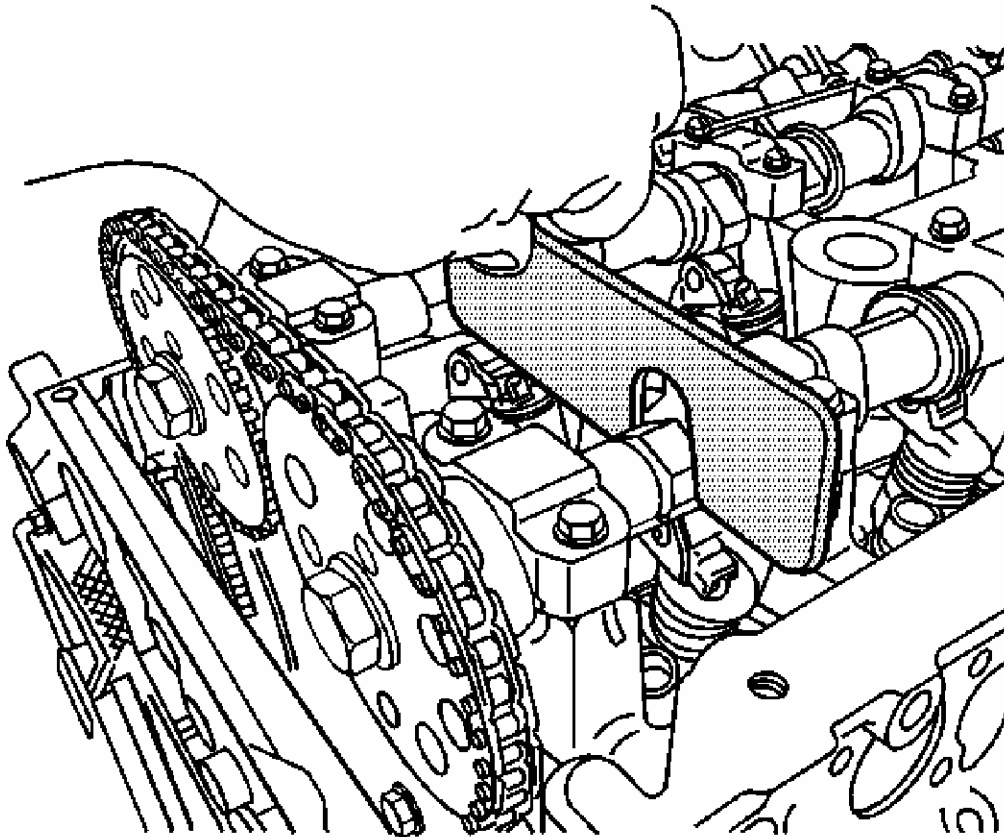


Fig. 181: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Camshaft Holding Tool Caution .

4. Install the **J 44212** over the camshafts. See Special Tools .

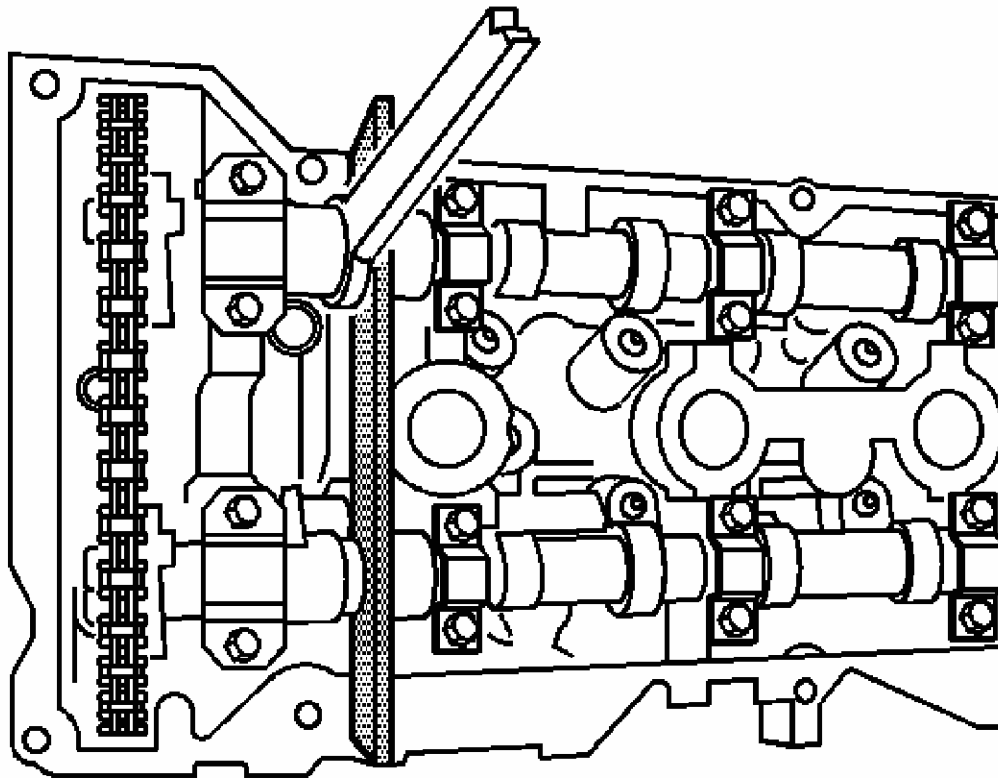


Fig. 182: Holding Camshaft
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Torque Reaction Against Timing Drive Chain Notice .

5. Use an open end wrench on the hex cast into the camshaft in order to prevent the camshaft from rotating when removing the camshaft sprocket bolt.

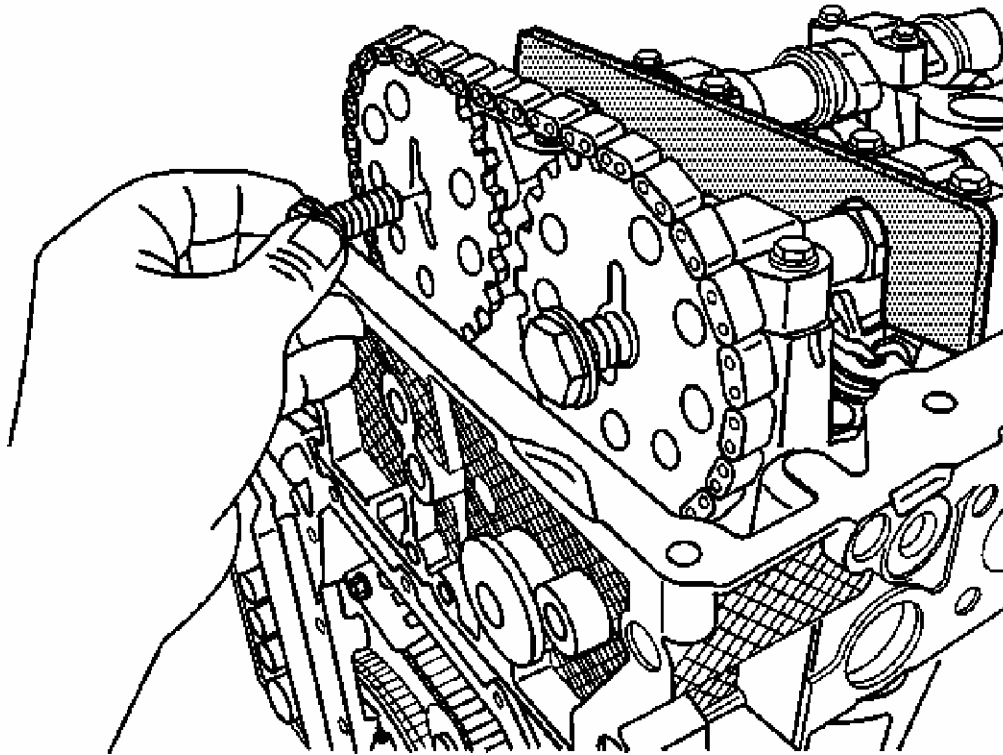


Fig. 183: Identifying Left Intake Camshaft Sprocket Bolt
Courtesy of GENERAL MOTORS CORP.

6. Remove the left intake camshaft sprocket bolt.
7. Slide the left intake camshaft sprocket off of the camshaft and remove the left secondary drive chain from the camshaft sprocket teeth.

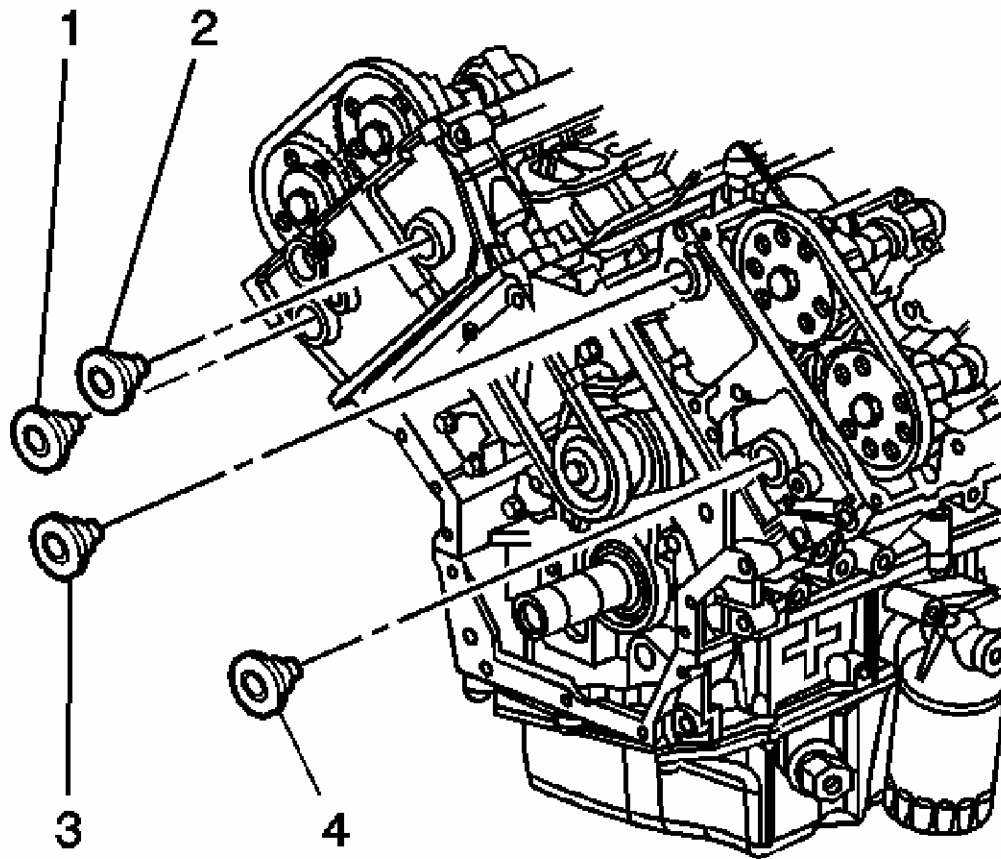


Fig. 184: Locating Camshaft Drive Chain Shoe Access Plugs On Front Of Engine
Courtesy of GENERAL MOTORS CORP.

8. Remove the left secondary camshaft drive chain shoe access plug (3) located in the cylinder head. Ensure the O-ring seal remains attached to the access plug.

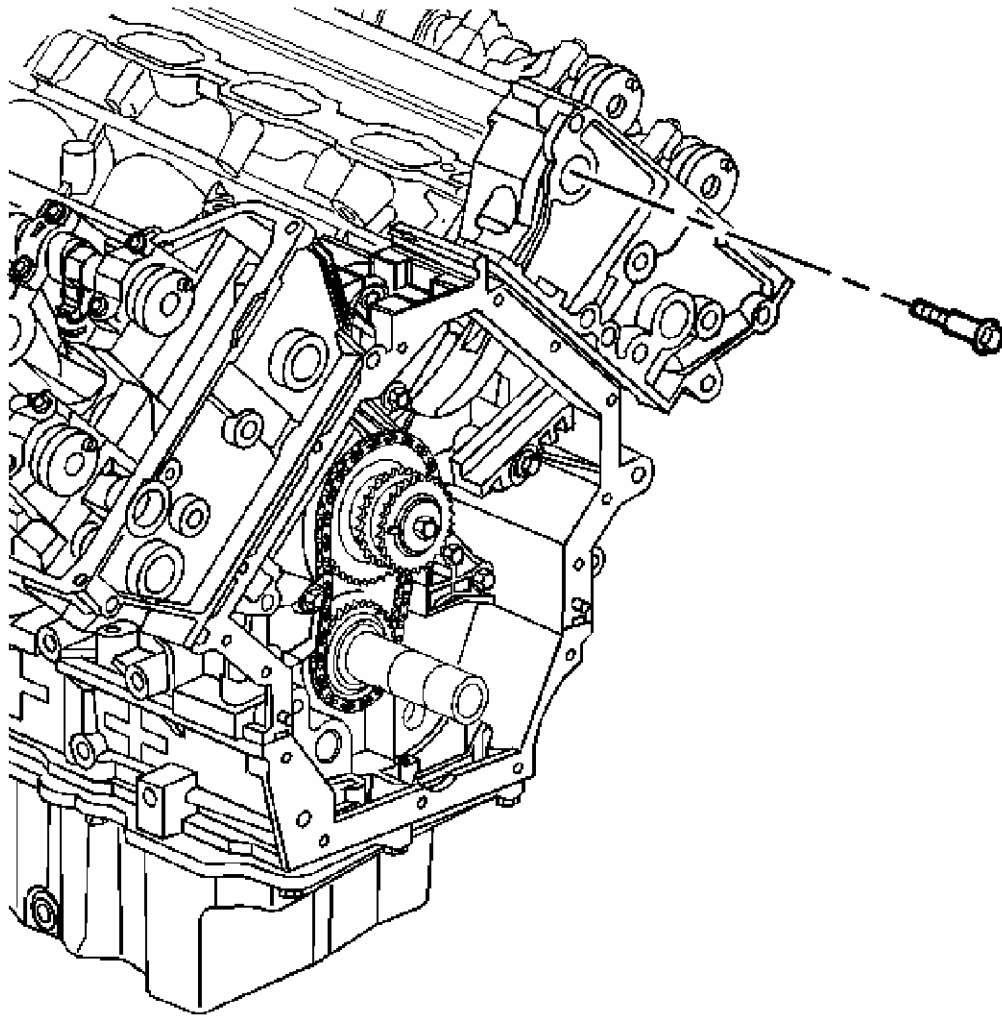


Fig. 185: Identifying Left Secondary Camshaft Drive Chain Shoe Bolt
Courtesy of GENERAL MOTORS CORP.

9. Remove the left secondary camshaft drive chain shoe bolt.

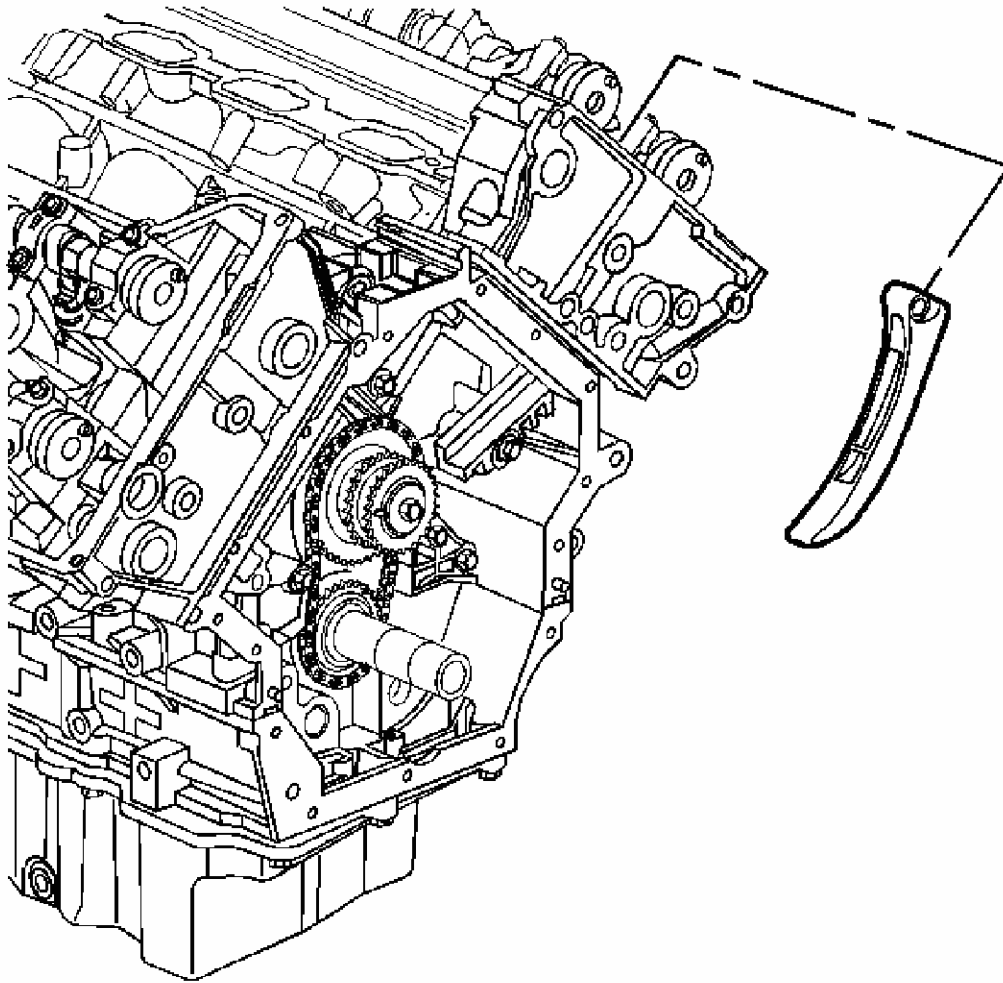


Fig. 186: View of Left Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS CORP.

10. Remove the left secondary camshaft drive chain shoe.
11. Clean and inspect the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** .

INSTALLATION PROCEDURE

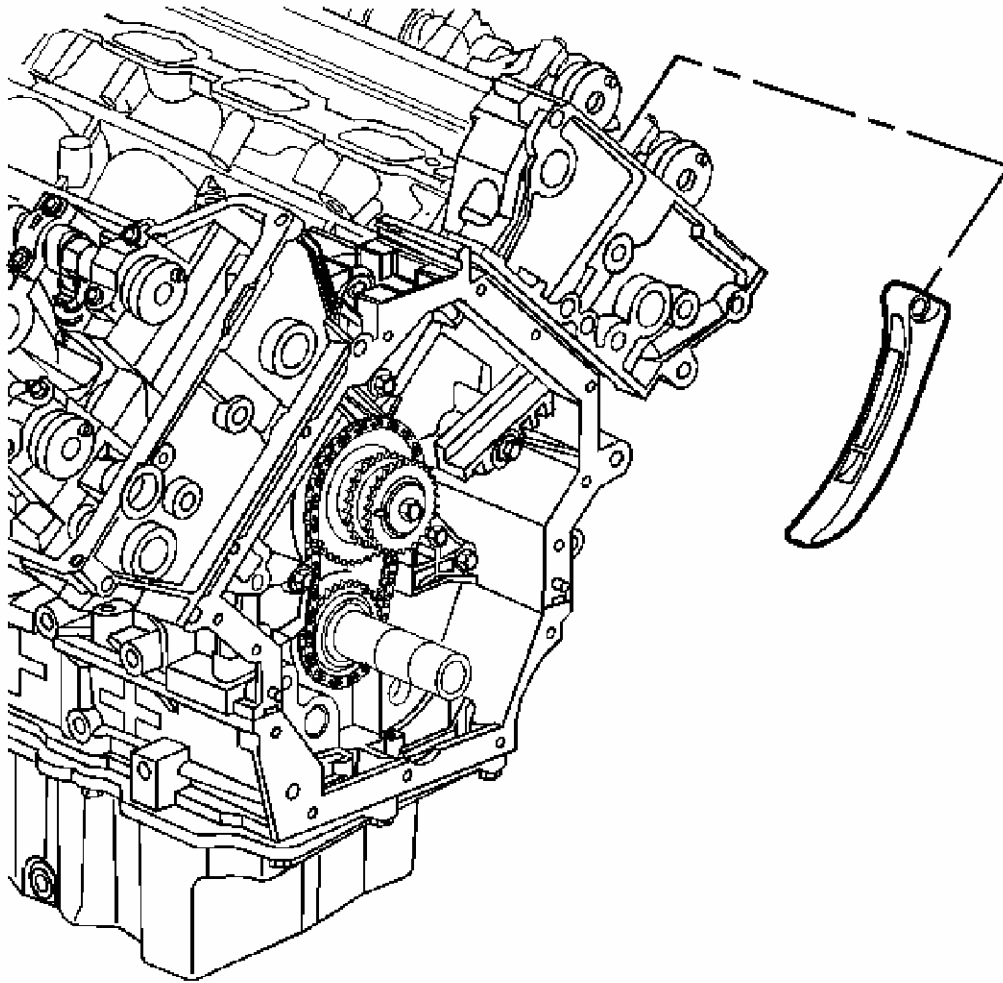


Fig. 187: View of Left Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS CORP.

1. Position the left secondary camshaft drive chain shoe in through the top of the cylinder head.

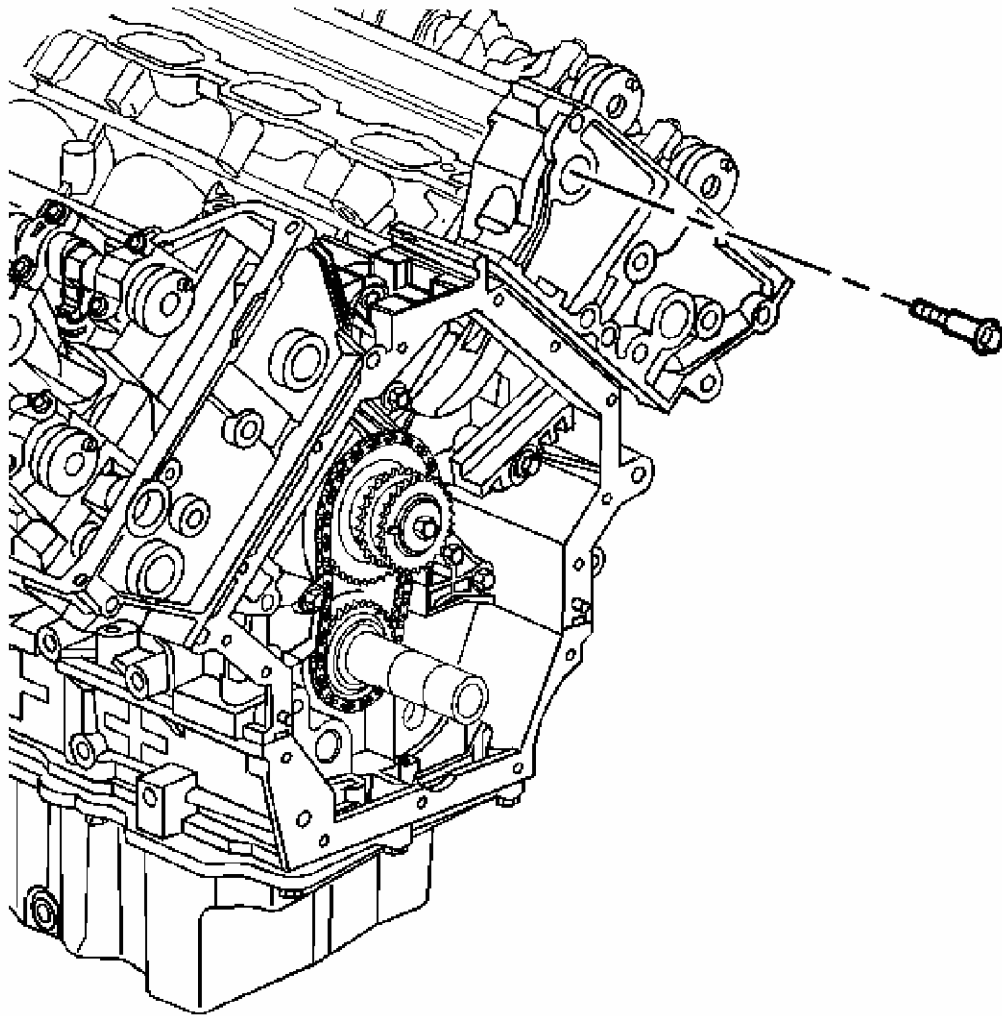


Fig. 188: Identifying Left Secondary Camshaft Drive Chain Shoe Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE .

2. Install the left secondary camshaft drive chain shoe bolt.

Tighten: Tighten the secondary camshaft drive chain shoe bolt to 25 N.m (18 lb ft).

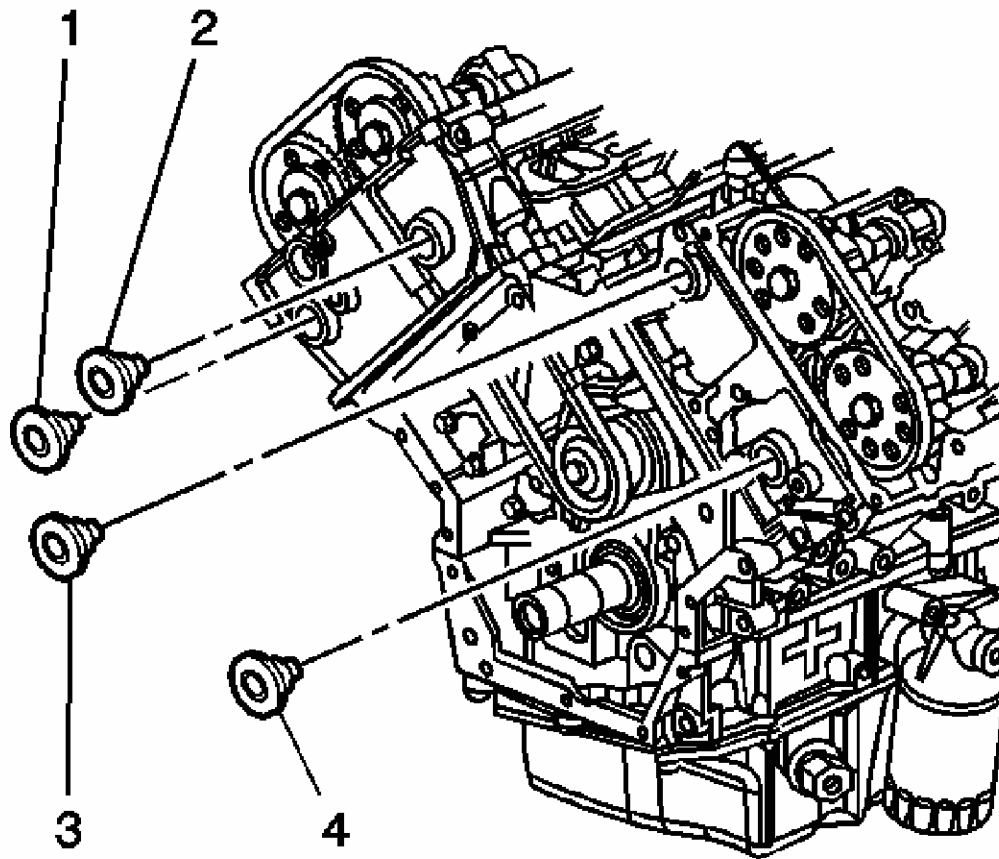


Fig. 189: Locating Camshaft Drive Chain Shoe Access Plugs On Front Of Engine
Courtesy of GENERAL MOTORS CORP.

3. Install the left secondary camshaft drive chain shoe access plug (3) located in the cylinder head. Ensure the O-ring seal is attached to the access plug.

Tighten: Tighten the secondary camshaft drive chain shoe access plug to 4.5 N.m (40 lb in).

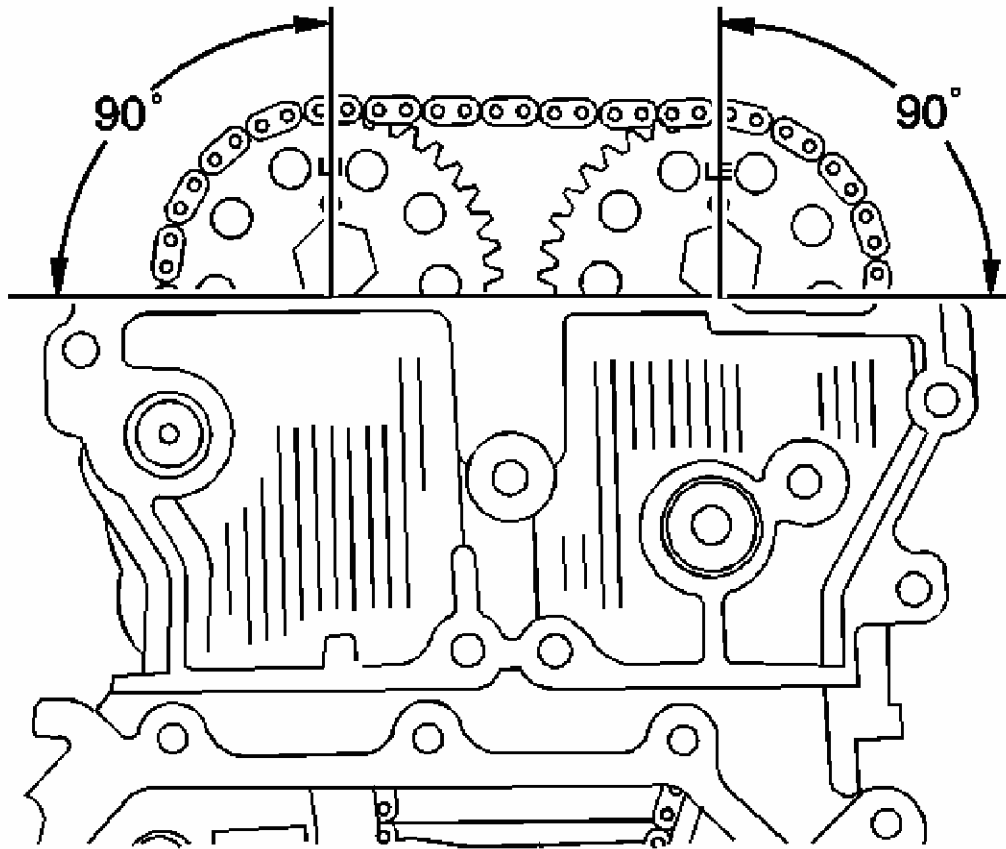


Fig. 190: Ensuring Camshaft Sprocket Drive Pins Are At The Top Of Their Rotation

Courtesy of GENERAL MOTORS CORP.

4. Install the left intake camshaft sprocket into the left secondary camshaft drive chain.
5. Install the left intake camshaft sprocket onto the camshaft. The camshaft sprocket notch marked LI (left intake) engages the intake camshaft pin.

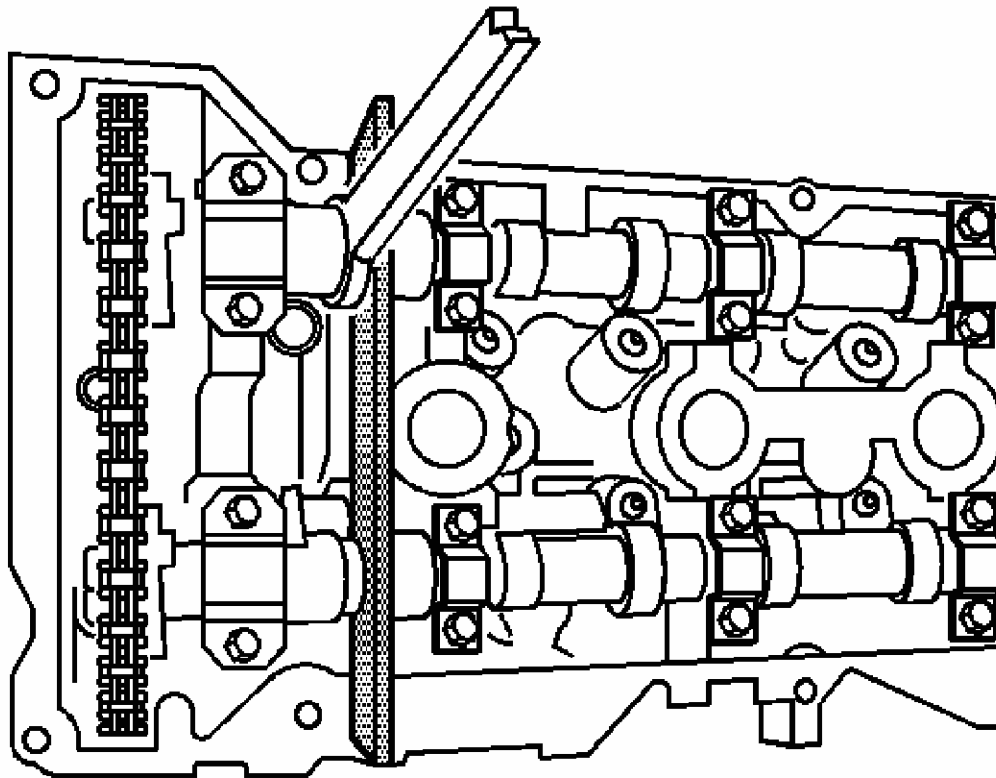


Fig. 191: Holding Camshaft
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Torque Reaction Against Timing Drive Chain Notice .

6. Use an open end wrench on the hex cast into the camshaft in order to prevent the camshaft from rotating when tightening the camshaft sprocket bolt.

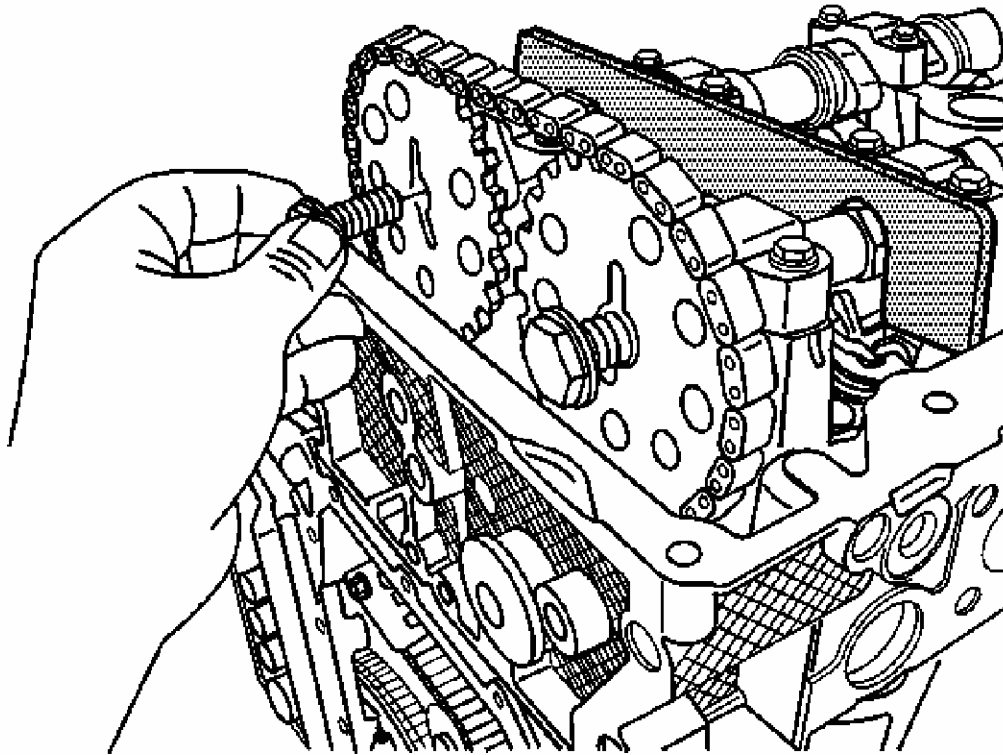


Fig. 192: Identifying Left Intake Camshaft Sprocket Bolt
Courtesy of GENERAL MOTORS CORP.

7. Install the left intake camshaft sprocket bolt.

Tighten: Tighten the camshaft sprocket bolt to 120 N.m (89 lb ft).

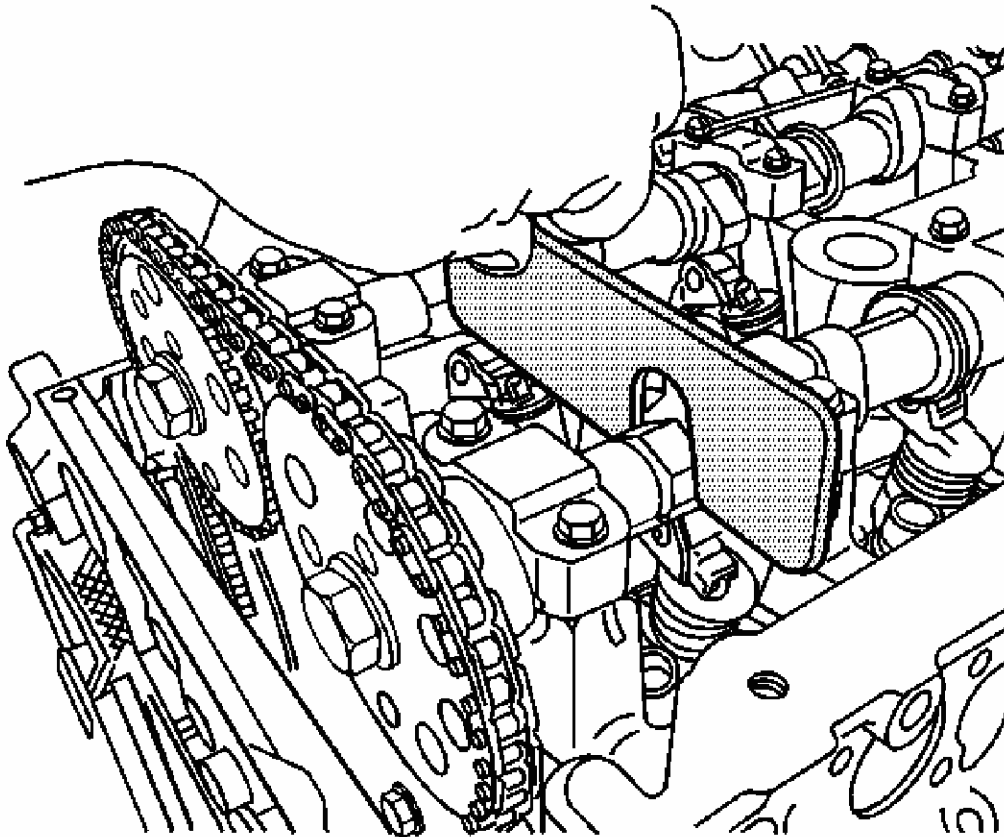


Fig. 193: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS CORP.

8. Remove the **J 44212** from the camshafts. See **Special Tools** .
9. Install the left camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.
10. Install the left secondary camshaft drive chain tensioner. Refer to **Secondary Camshaft Drive Chain Tensioner Replacement - Left Side**.

SECONDARY CAMSHAFT DRIVE CHAIN SHOE REPLACEMENT - RIGHT SIDE

TOOLS REQUIRED

J 44212 Camshaft Holding Tool. See **Special Tools** .

REMOVAL PROCEDURE

1. Remove the right secondary camshaft drive chain tensioner. Refer to **Secondary Camshaft Drive Chain Tensioner Replacement - Right Side**.
2. Remove the right camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.

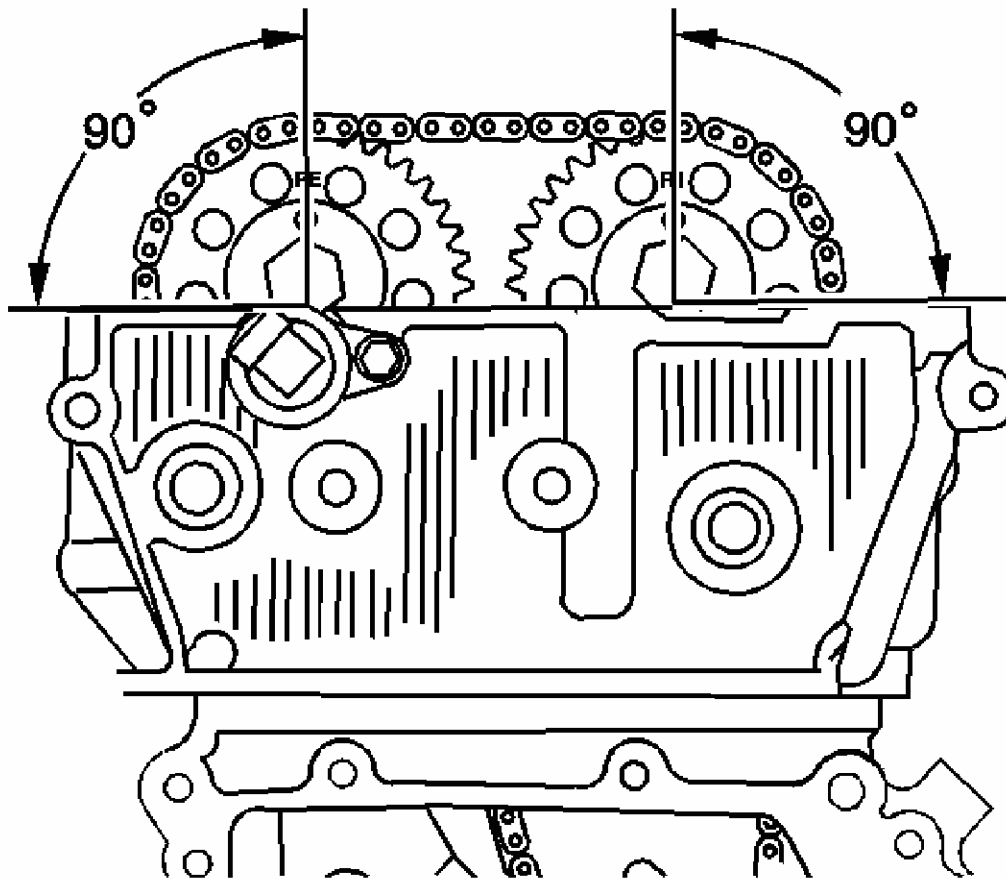


Fig. 194: Ensuring Camshaft Sprocket Drive Pins Are At Top Of Their Rotation
Courtesy of GENERAL MOTORS CORP.

3. Ensure both camshaft sprocket drive pins are at the top of their rotation.

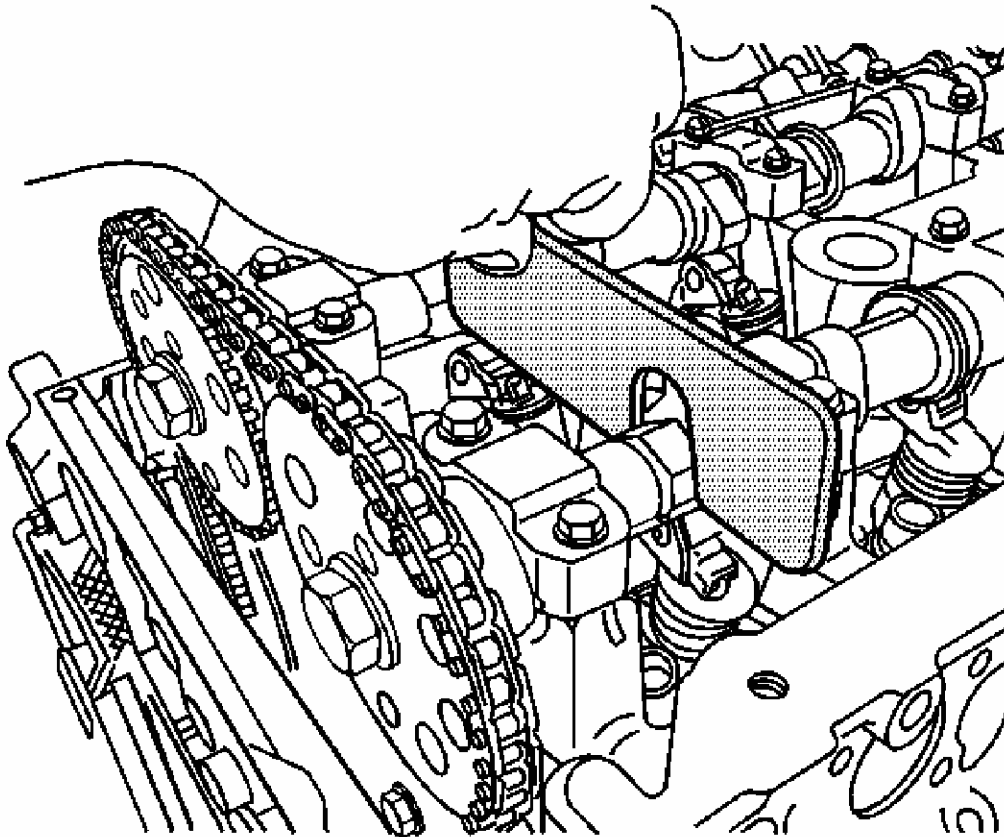


Fig. 195: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to CAMSHAFT HOLDING TOOL CAUTION .

4. Install the **J 44212** over the camshafts. See Special Tools .

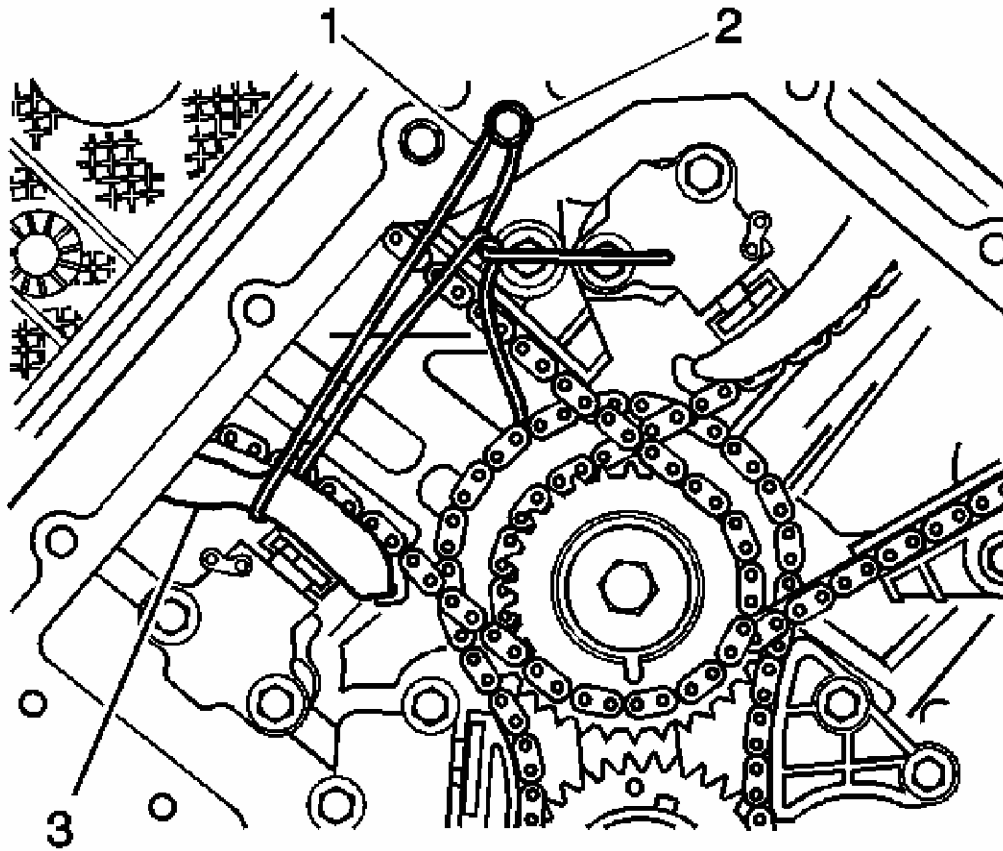


Fig. 196: View Of Mechanics Wire, Right Secondary Camshaft Drive Chain Shoe & Front Cover Bolt

Courtesy of GENERAL MOTORS CORP.

5. Remove the mechanics wire (1) supporting the right secondary camshaft drive chain shoe (3).
6. Remove the engine front cover bolt (2) from the front of the engine.

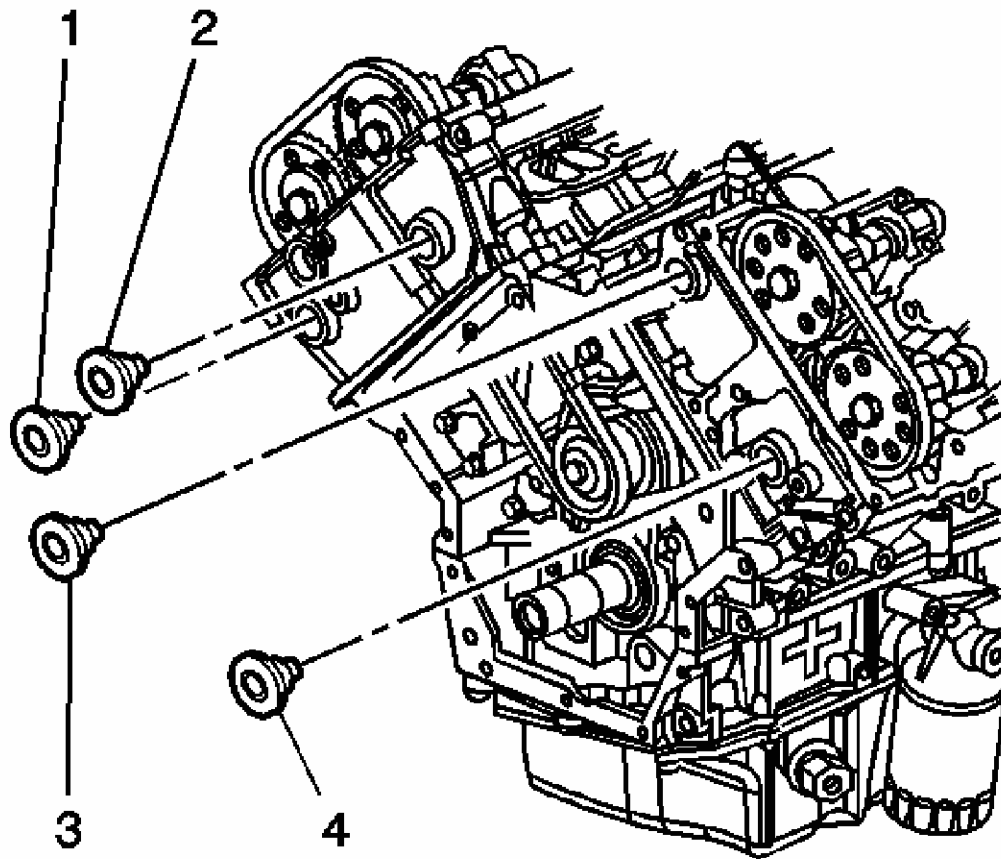


Fig. 197: Locating Camshaft Drive Chain Shoe Access Plugs On Front Of Engine
Courtesy of GENERAL MOTORS CORP.

7. Remove the right secondary camshaft drive chain shoe access plug (1) located in the cylinder head. Ensure the O-ring seal remains attached to the access plug.

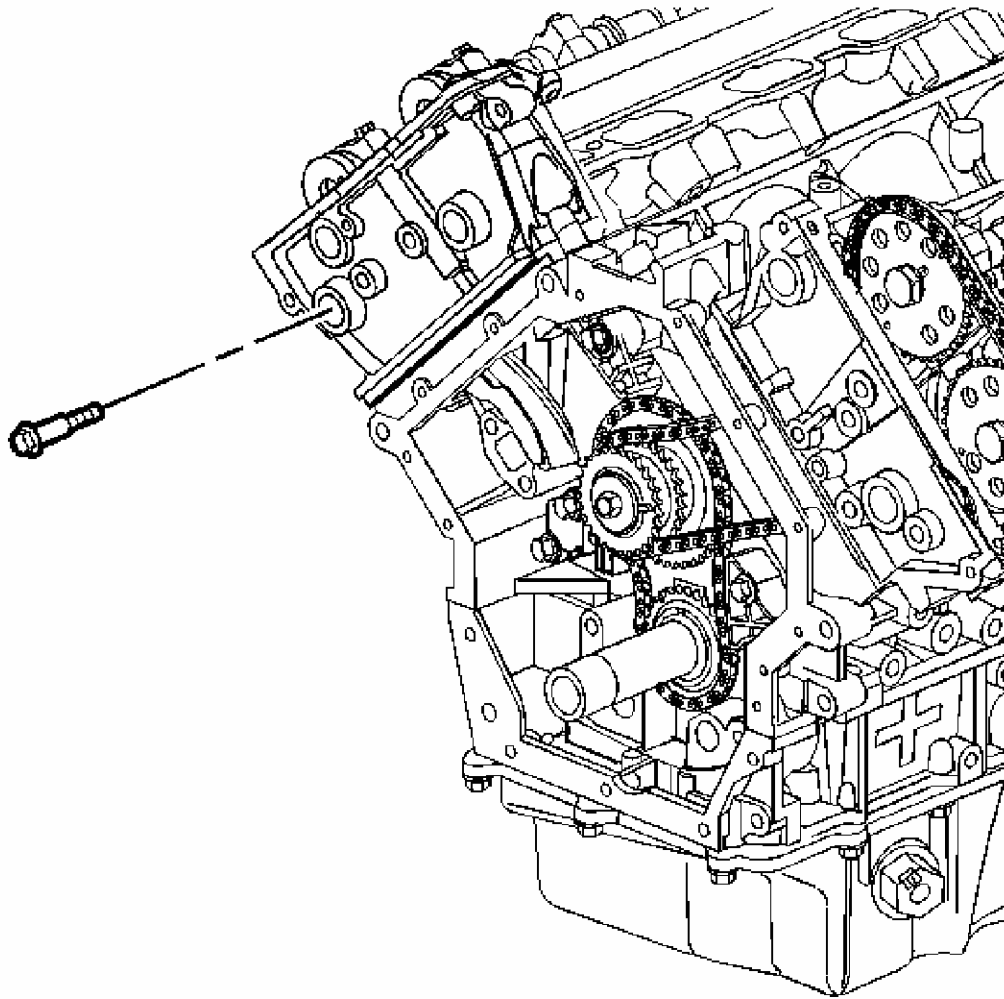


Fig. 198: Identifying Right Secondary Camshaft Drive Chain Shoe Bolt
Courtesy of GENERAL MOTORS CORP.

8. Remove the right secondary camshaft drive chain shoe bolt.

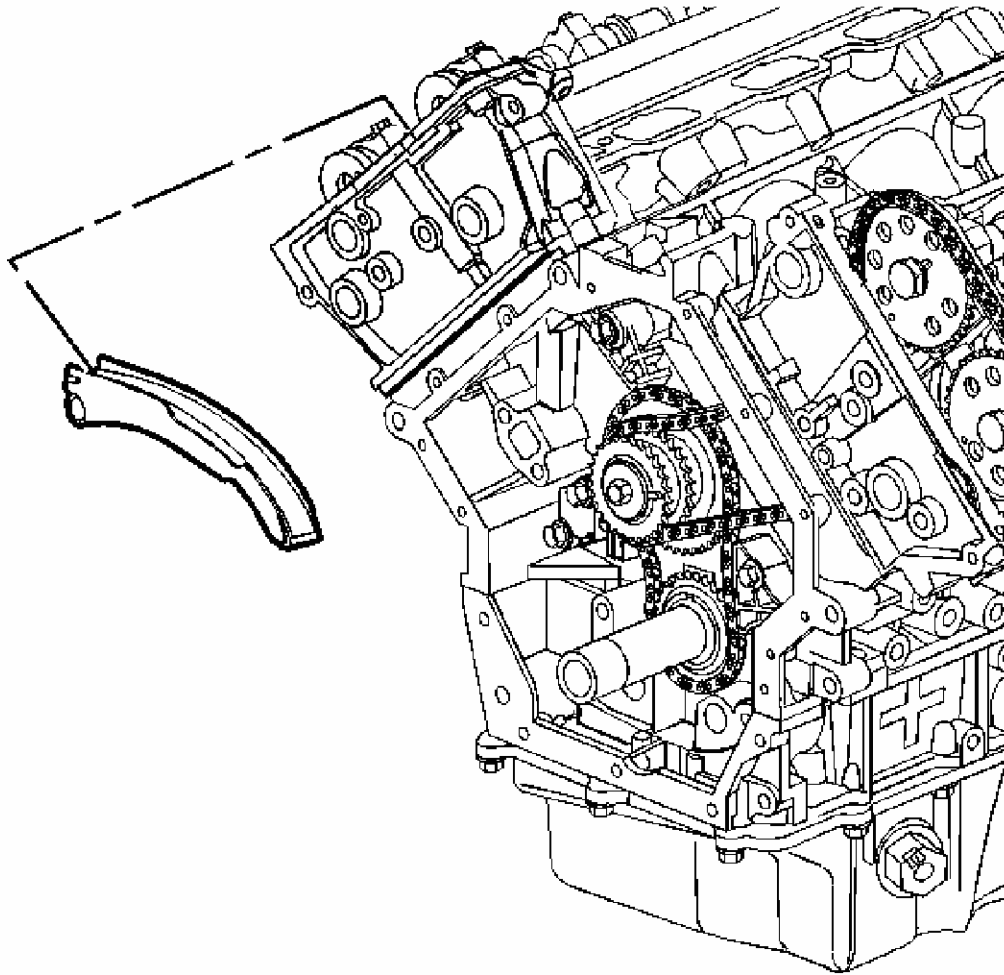


Fig. 199: View of Right Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS CORP.

9. Remove the right secondary camshaft drive chain shoe.
10. Clean and inspect the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** .

INSTALLATION PROCEDURE

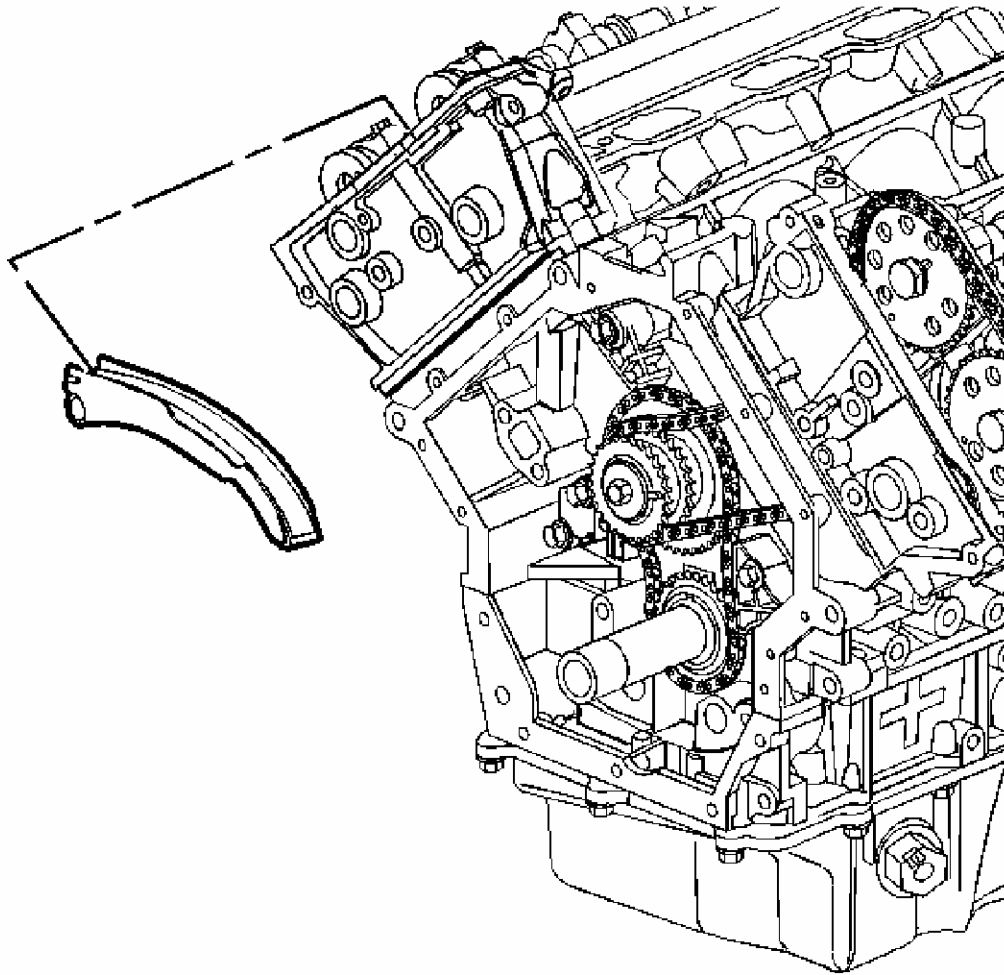


Fig. 200: View of Right Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS CORP.

1. Position the right secondary camshaft drive chain shoe in through the front cover area.

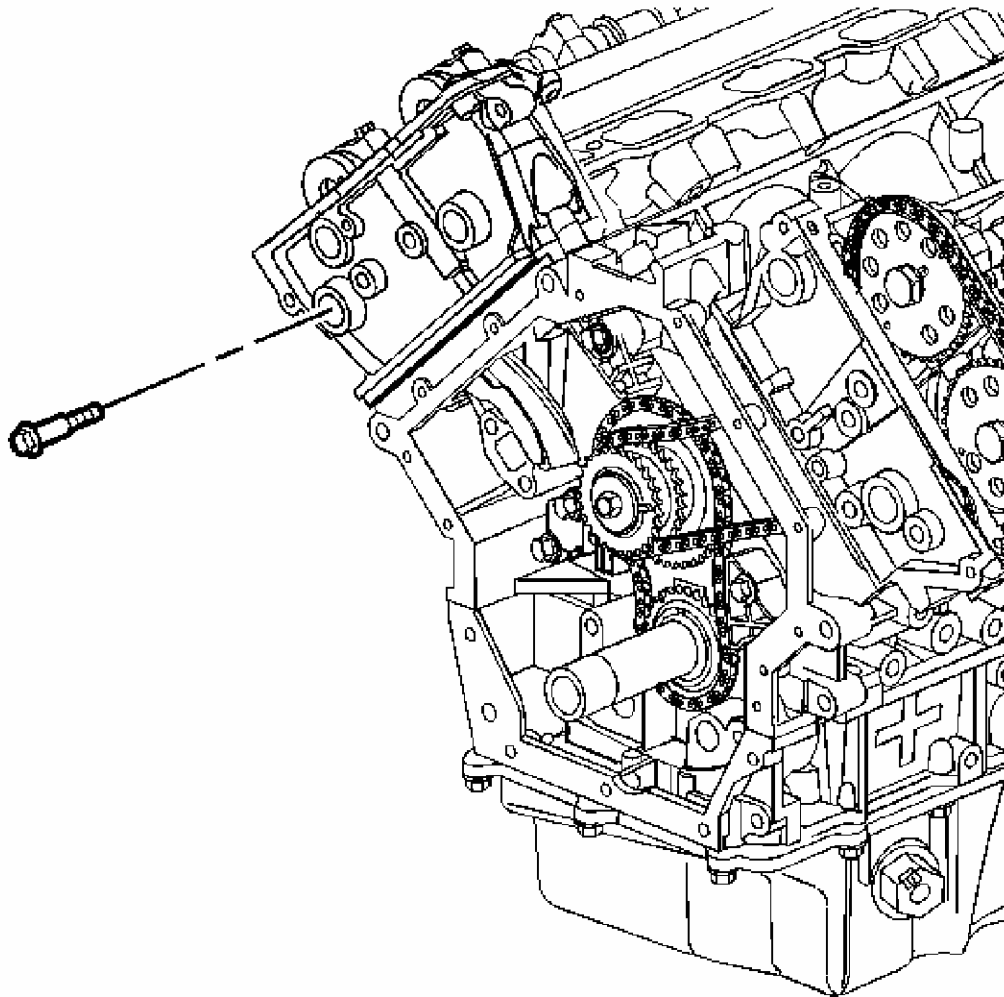


Fig. 201: Identifying Right Secondary Camshaft Drive Chain Shoe Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE .

2. Install the right secondary camshaft drive chain shoe bolt.

Tighten: Tighten the secondary camshaft drive chain shoe bolt to 25 N.m (18 lb ft).

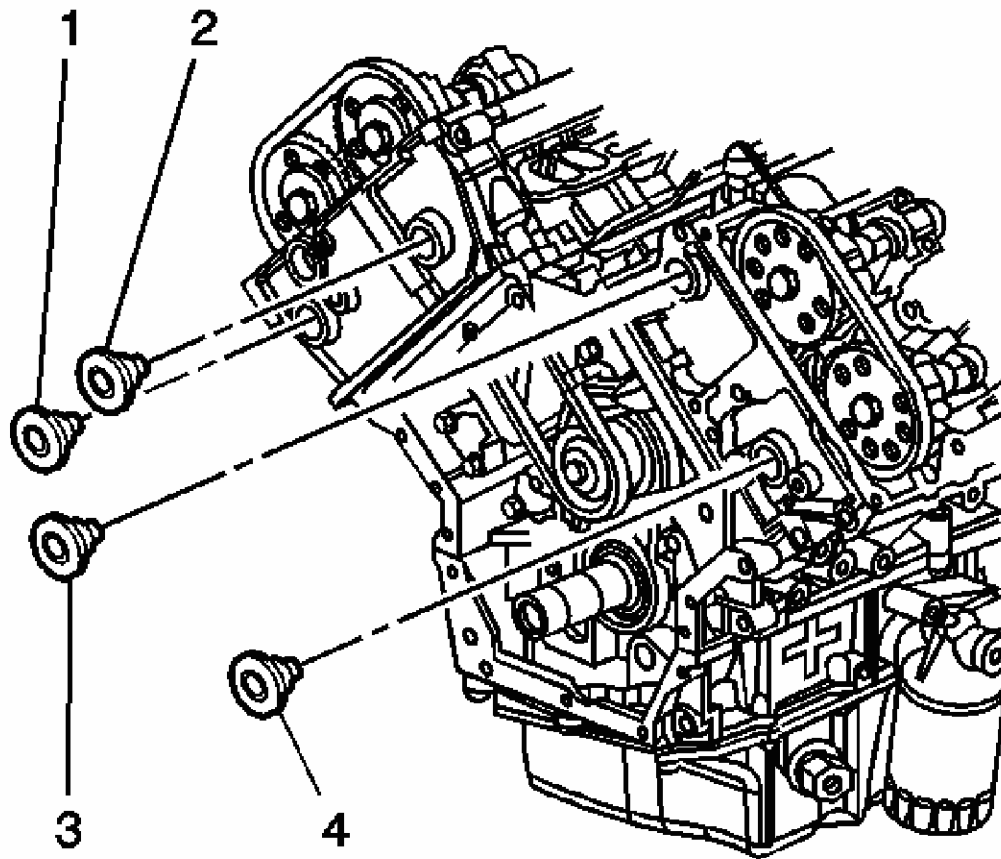


Fig. 202: Locating Camshaft Drive Chain Shoe Access Plugs On Front Of Engine
 Courtesy of GENERAL MOTORS CORP.

3. Install the right secondary camshaft drive chain shoe access plug (1) located in the cylinder head. Ensure the O-ring seal is attached to the access plug.

Tighten: Tighten the secondary camshaft drive chain shoe access plug to 4.5 N.m (40 lb in).

4. Install the right secondary camshaft drive chain tensioner. Refer to **Secondary Camshaft Drive Chain Tensioner Replacement - Right Side**.

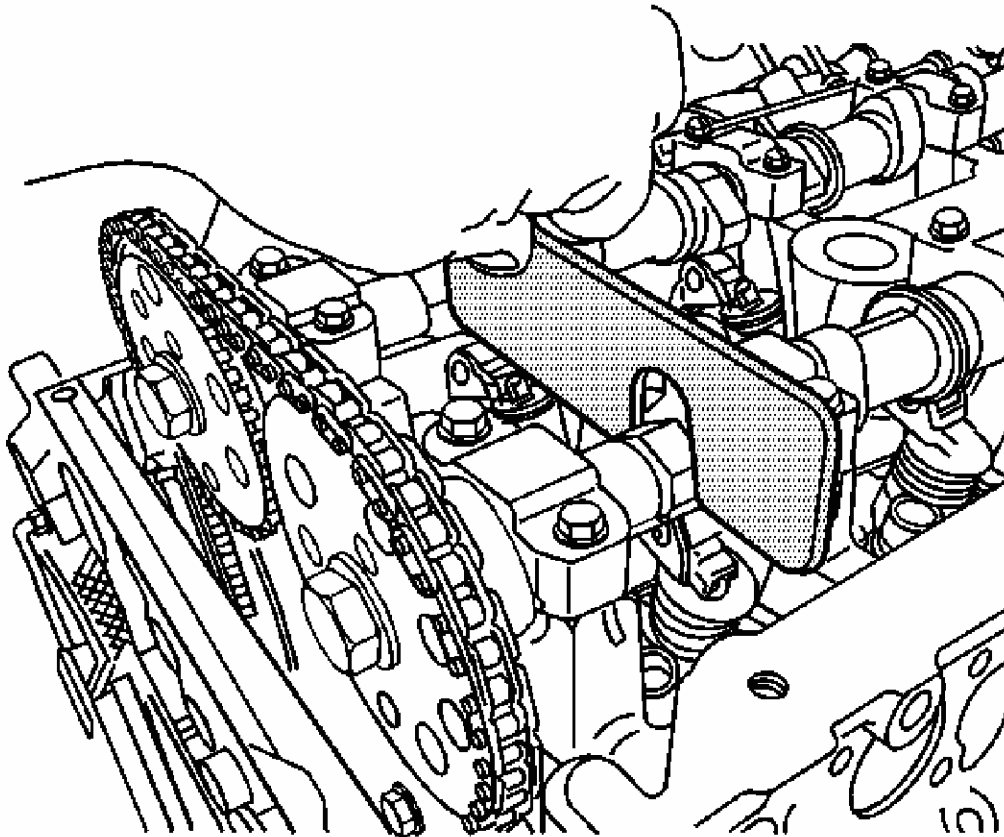


Fig. 203: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS CORP.

5. Remove the **J 44212** from the camshafts. See **Special Tools** .
6. Install the right camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.

SECONDARY CAMSHAFT DRIVE CHAIN GUIDE REPLACEMENT - LEFT SIDE

TOOLS REQUIRED

J 44212 Camshaft Holding Tool. See **Special Tools** .

REMOVAL PROCEDURE

1. Remove the left secondary camshaft drive chain tensioner. Refer to **Secondary Camshaft Drive Chain Tensioner Replacement - Left Side**.

2. Remove the left camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.

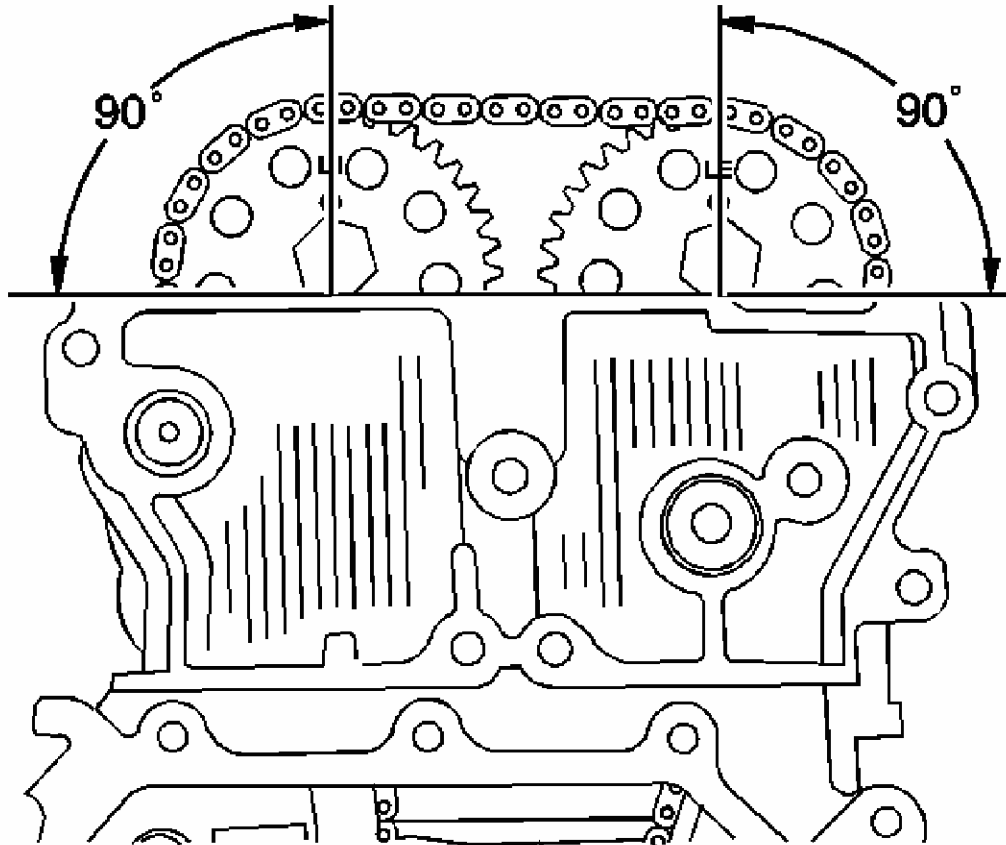


Fig. 204: Ensuring Camshaft Sprocket Drive Pins Are At The Top Of Their Rotation

Courtesy of GENERAL MOTORS CORP.

3. Ensure both camshaft sprocket drive pins are at the top of their rotation.

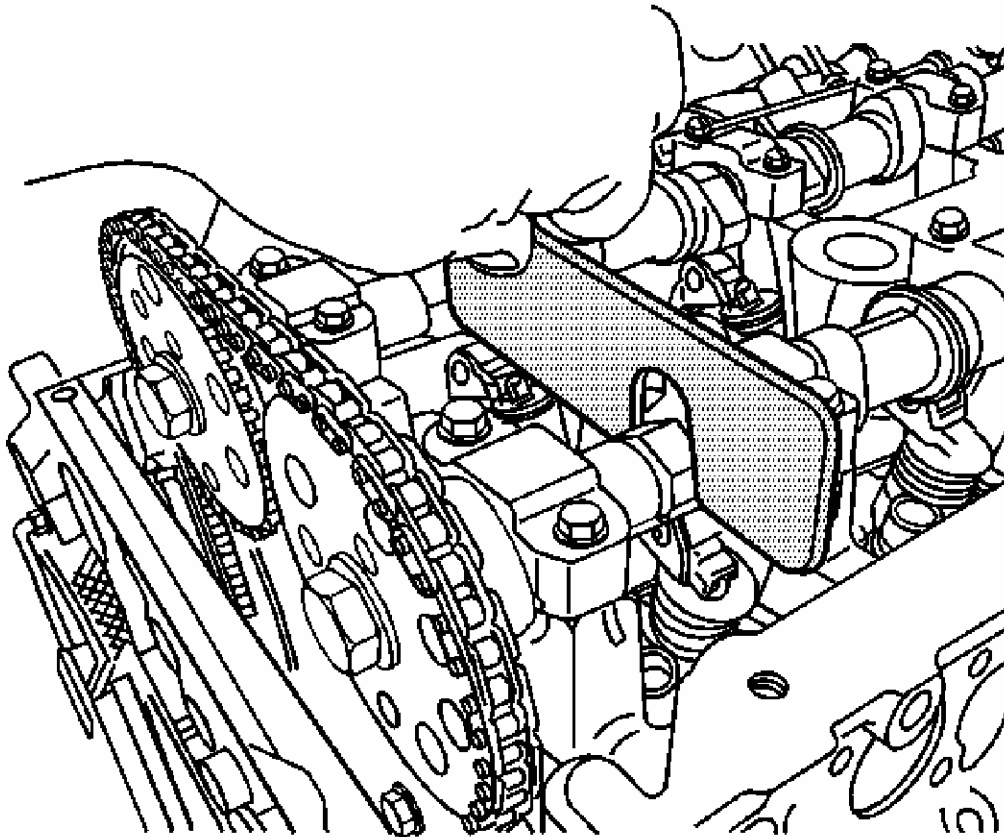


Fig. 205: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to CAMSHAFT HOLDING TOOL CAUTION .

4. Install the **J 44212** over the camshafts. See Special Tools .

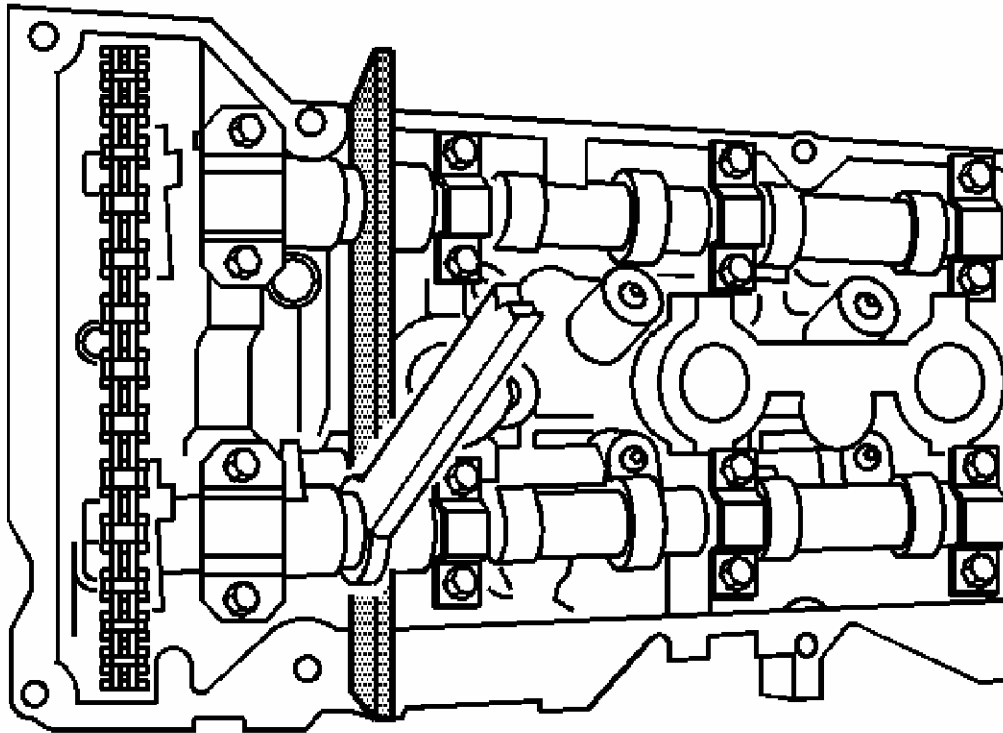


Fig. 206: Securing Camshaft
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Torque Reaction Against Timing Drive Chain Notice .

5. Use an open end wrench on the hex cast into the camshaft in order to prevent the camshaft from rotating when removing the camshaft sprocket bolt.

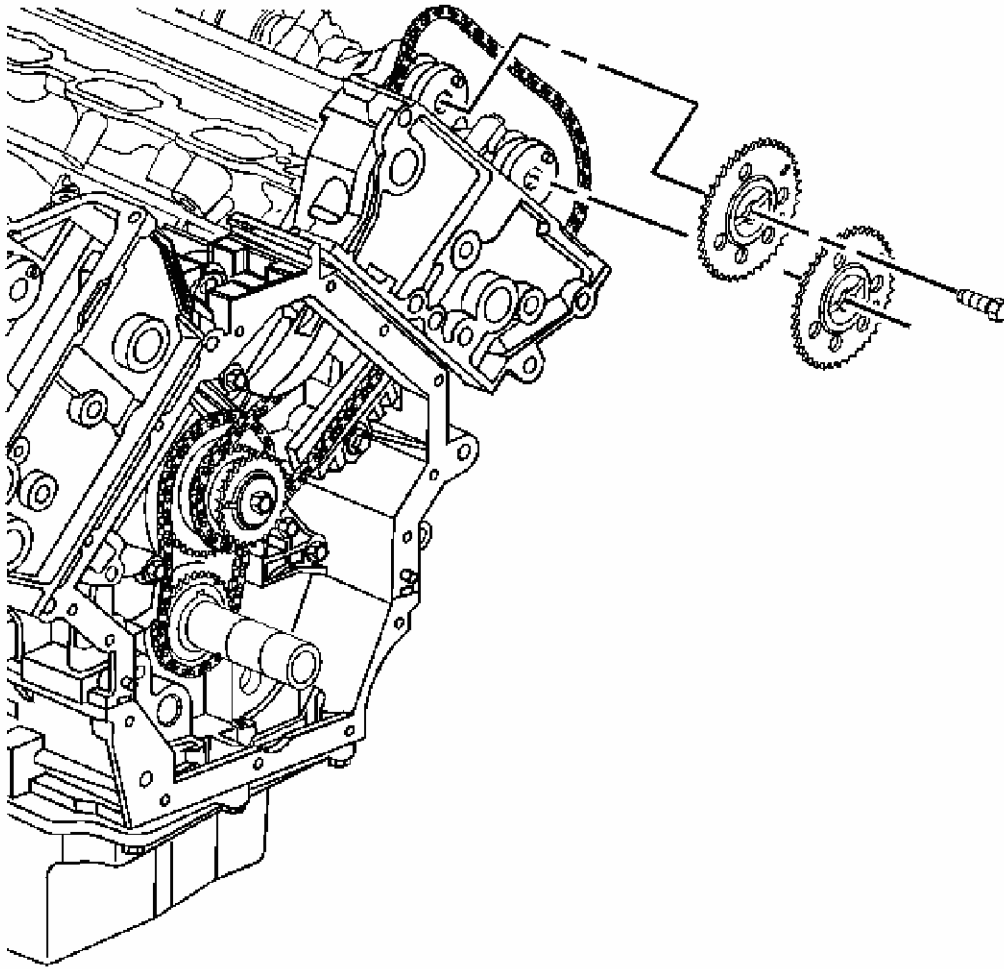


Fig. 207: Identifying Left Exhaust Camshaft Sprocket Bolt
Courtesy of GENERAL MOTORS CORP.

6. Remove the left exhaust camshaft sprocket bolt.
7. Slide the left exhaust camshaft sprocket off of the camshaft and remove the left secondary drive chain from the camshaft sprocket teeth.

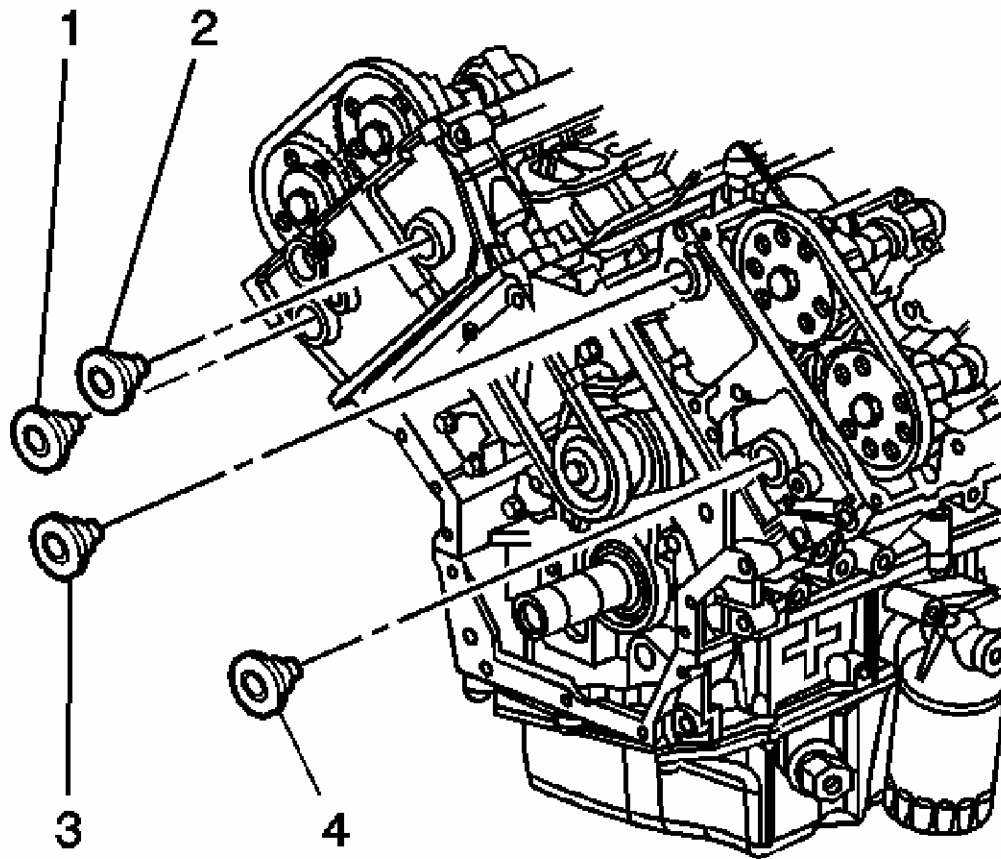


Fig. 208: Locating Camshaft Drive Chain Shoe Access Plugs On Front Of Engine
Courtesy of GENERAL MOTORS CORP.

8. Remove the left secondary camshaft drive chain guide access plug (4) located in the cylinder head. Ensure the O-ring seal remains attached to the access plug.

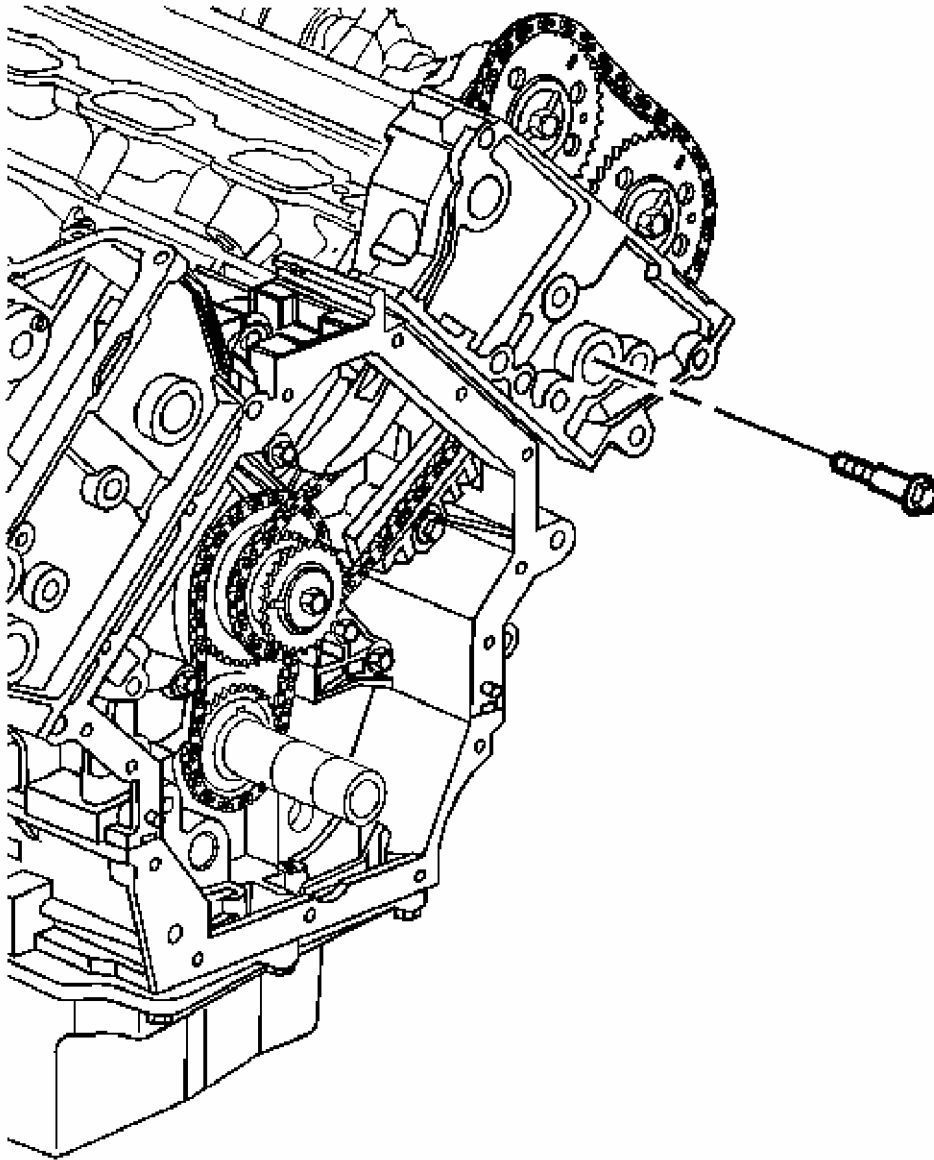


Fig. 209: Identifying Upper Left Secondary Camshaft Drive Chain Guide Bolt
Courtesy of GENERAL MOTORS CORP.

9. Remove the upper left secondary camshaft drive chain guide bolt.

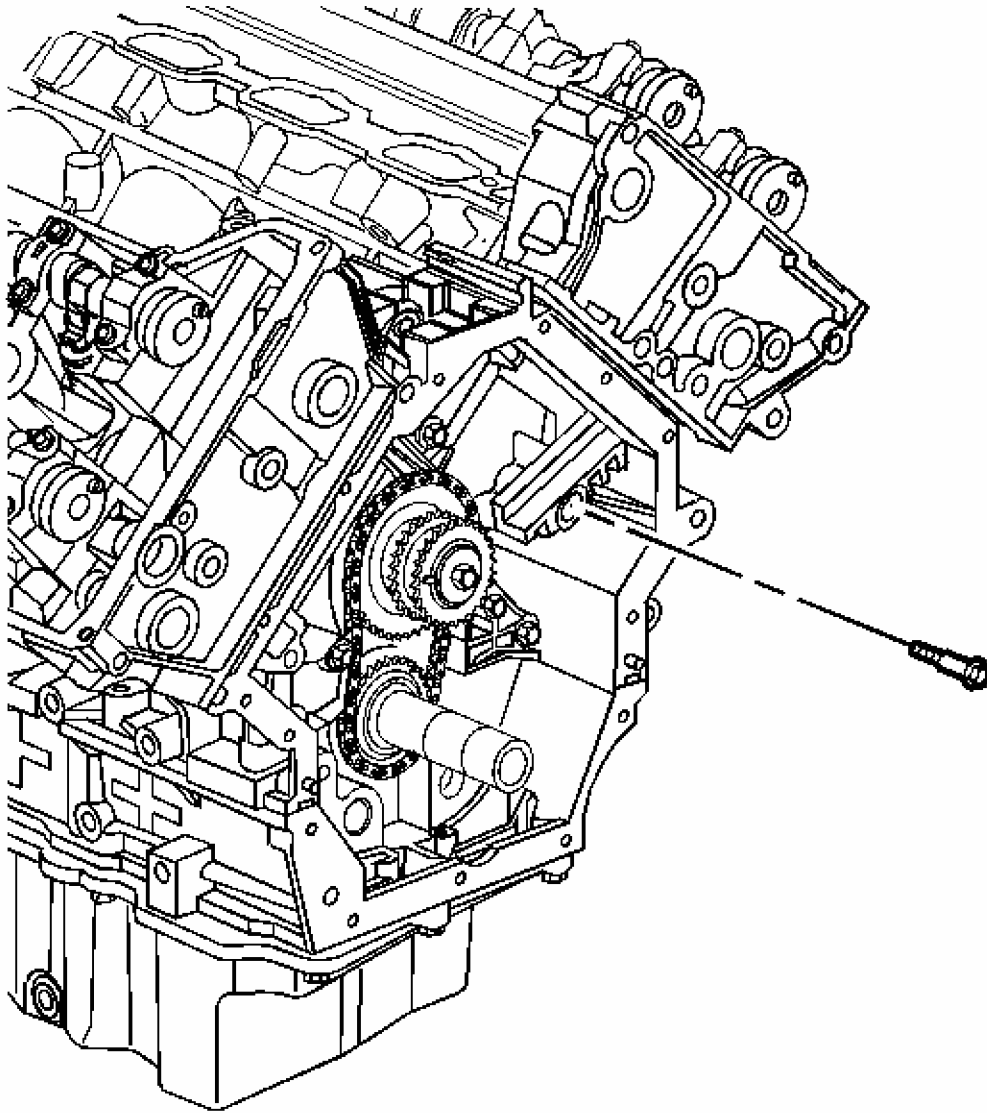


Fig. 210: Identifying Lower Left Secondary Camshaft Drive Chain Guide Bolt
Courtesy of GENERAL MOTORS CORP.

10. Remove the lower left secondary camshaft drive chain guide bolt.

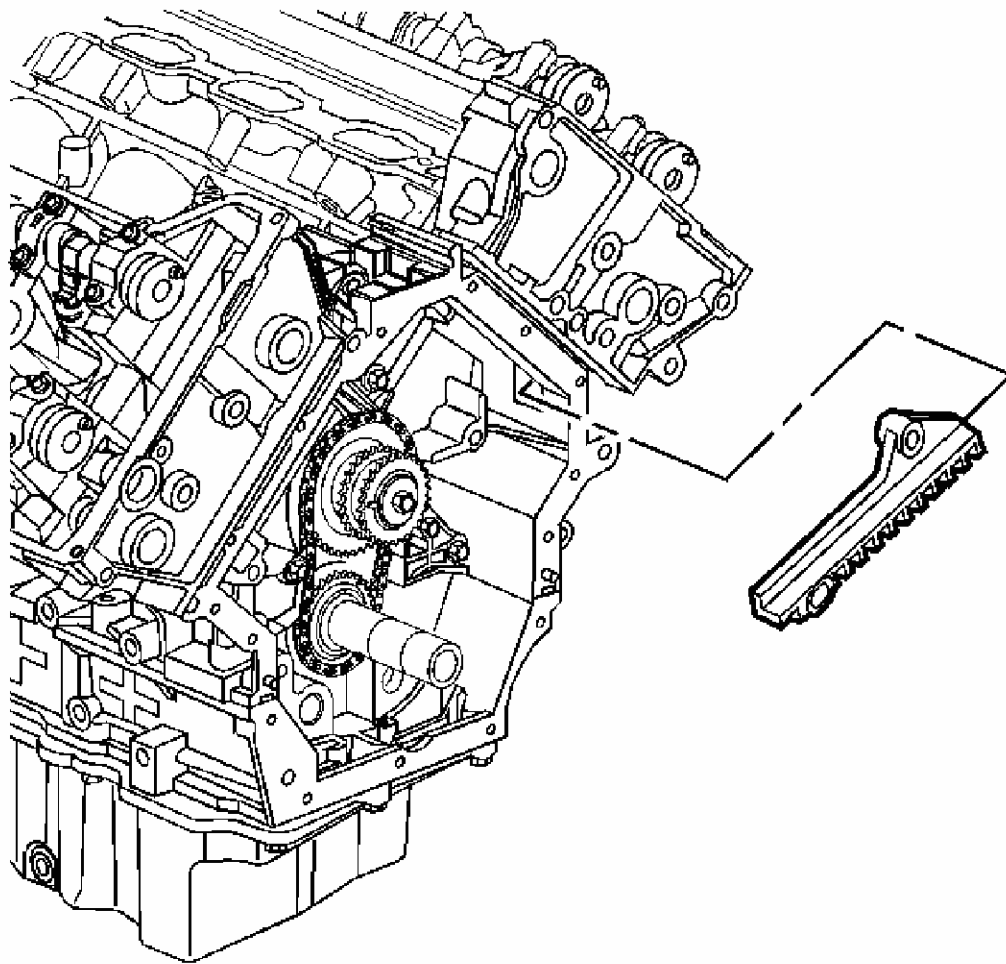


Fig. 211: View Of Left Secondary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS CORP.

11. Remove the left secondary camshaft drive chain guide.
12. Clean and inspect the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** .

INSTALLATION PROCEDURE

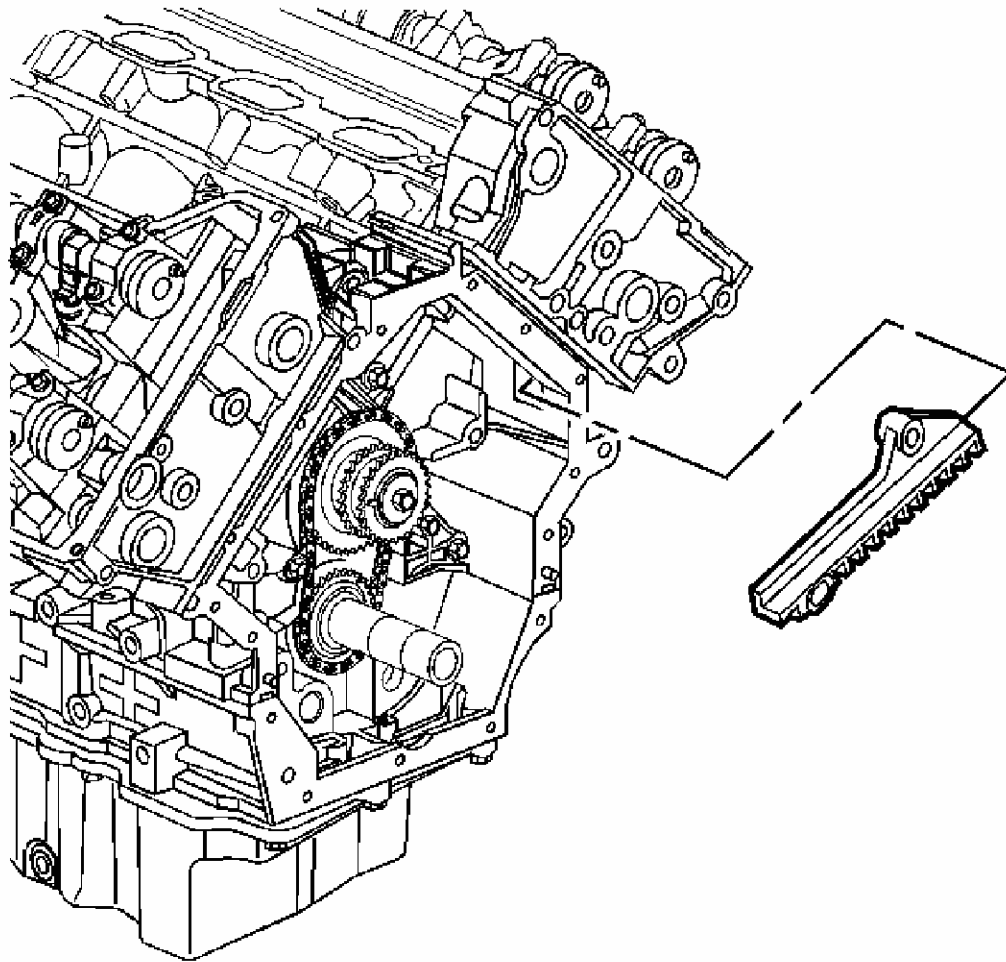


Fig. 212: View Of Left Secondary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS CORP.

1. Position the left secondary camshaft drive chain guide in through the top of the cylinder head.

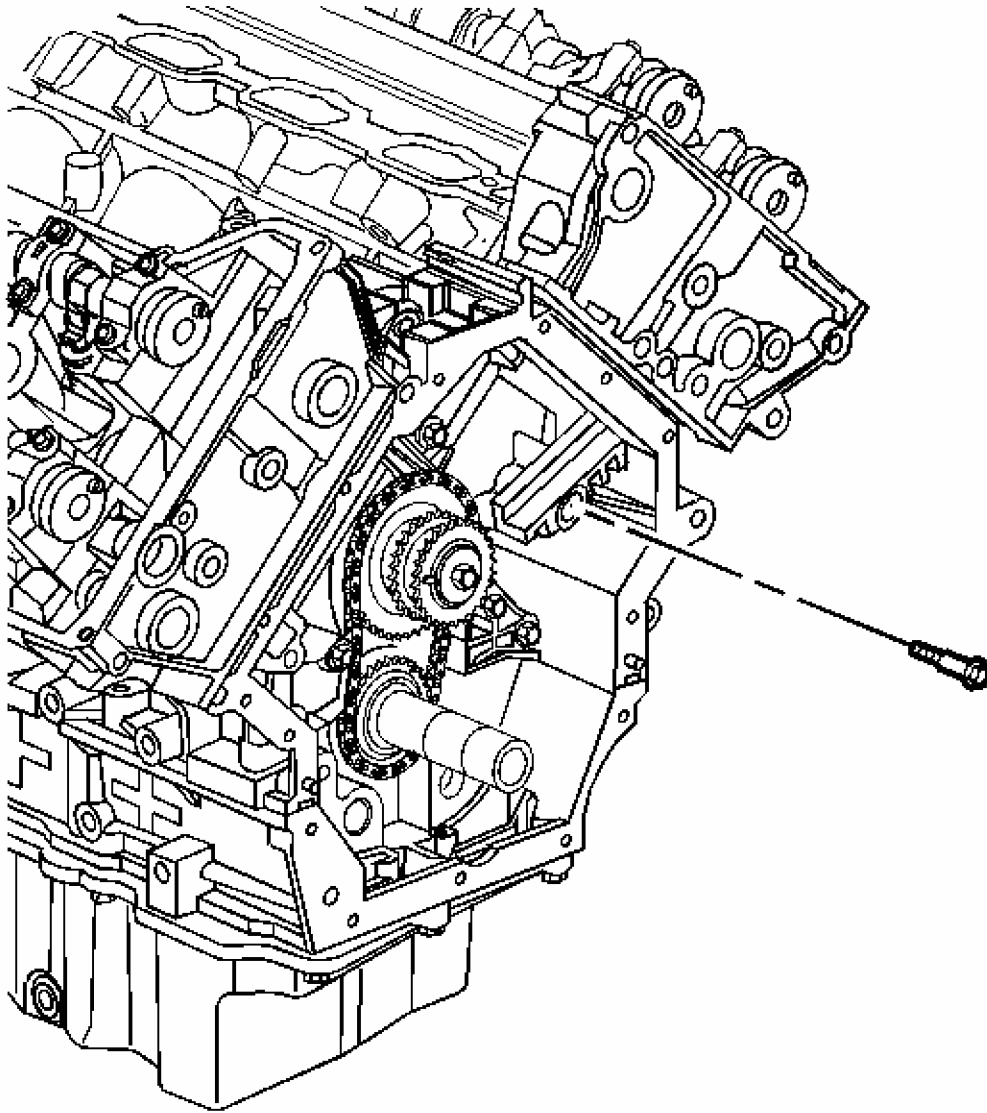


Fig. 213: Identifying Lower Left Secondary Camshaft Drive Chain Guide Bolt
Courtesy of GENERAL MOTORS CORP.

2. Loosely install the lower left secondary camshaft drive chain guide bolt.

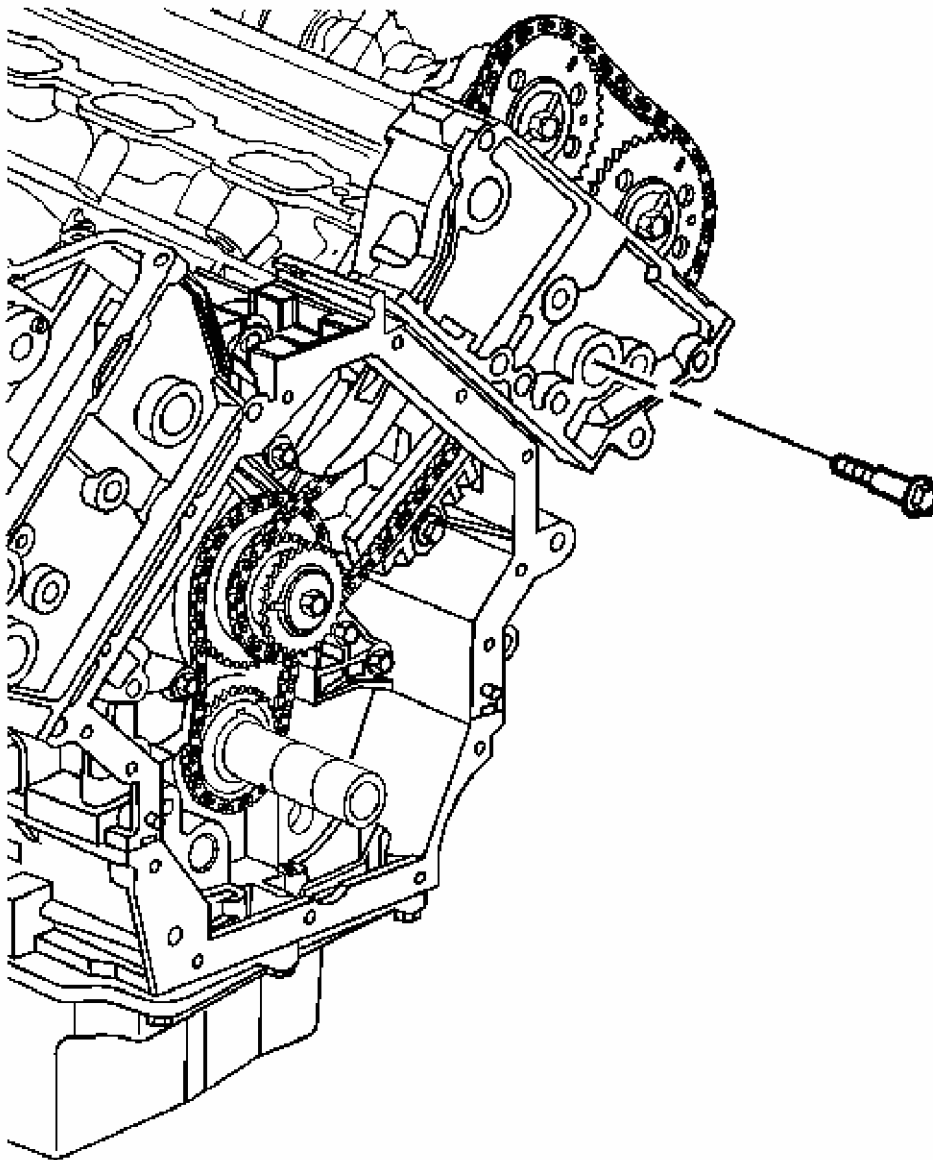


Fig. 214: Identifying Upper Left Secondary Camshaft Drive Chain Guide Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE .

3. Install the upper left secondary camshaft drive chain guide bolt.

Tighten: Tighten the secondary camshaft drive chain guide bolts to 25 N.m (18 lb ft).

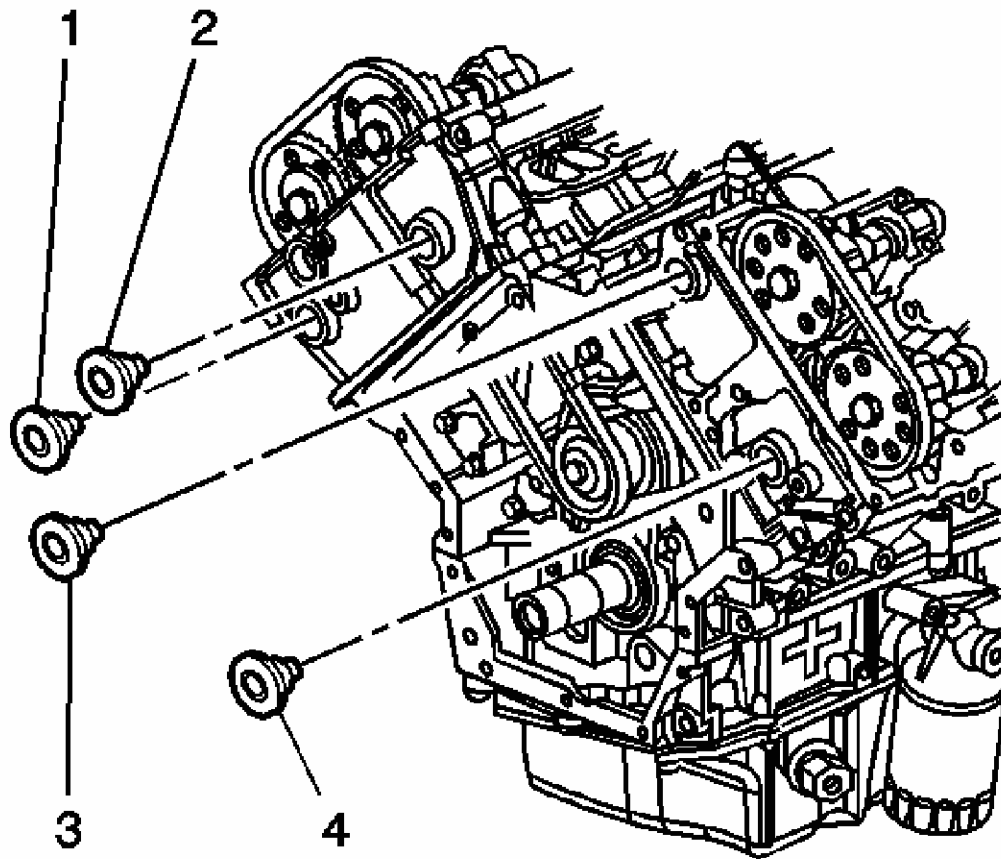


Fig. 215: Locating Camshaft Drive Chain Shoe Access Plugs On Front Of Engine
Courtesy of GENERAL MOTORS CORP.

4. Install the left secondary camshaft drive chain guide access plug (4) located in the cylinder head. Ensure the O-ring seal is attached to the access plug.

Tighten: Tighten the secondary camshaft drive chain guide access plug to 4.5 N.m (40 lb in).

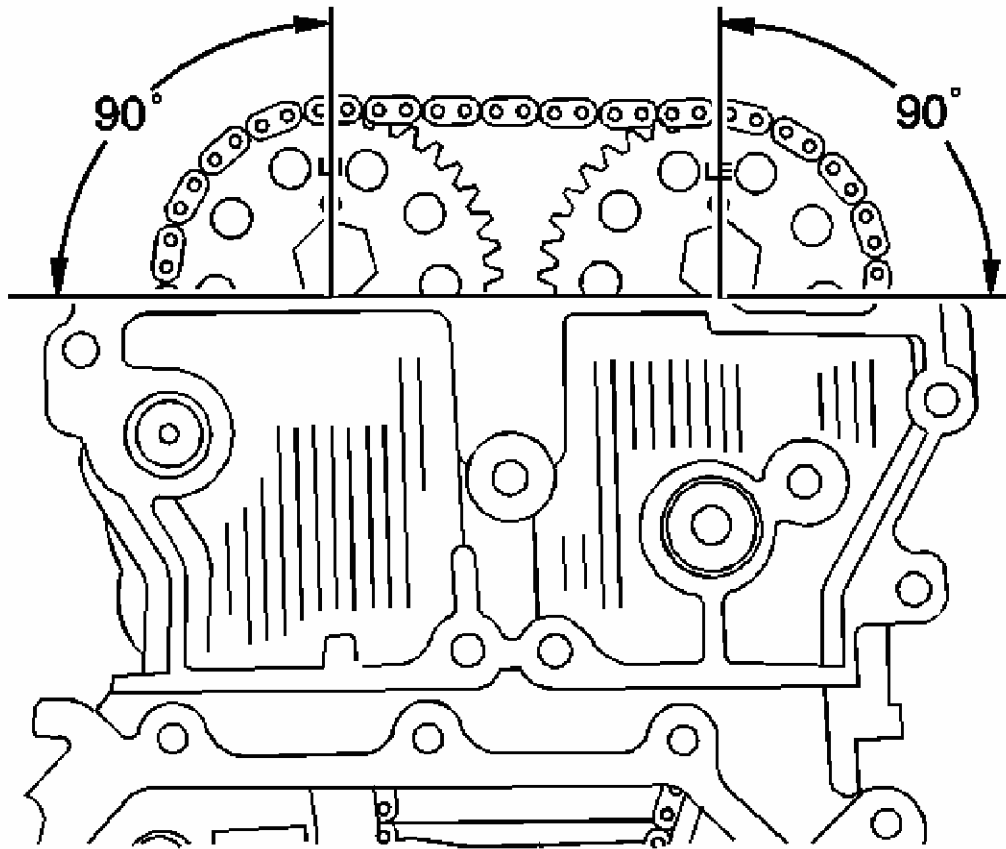


Fig. 216: Ensuring Camshaft Sprocket Drive Pins Are At The Top Of Their Rotation

Courtesy of GENERAL MOTORS CORP.

5. Install the left exhaust camshaft sprocket into the left secondary camshaft drive chain.
6. Install the left exhaust camshaft sprocket onto the camshaft. The camshaft sprocket notch marked LE (left exhaust) engages the exhaust camshaft pin.

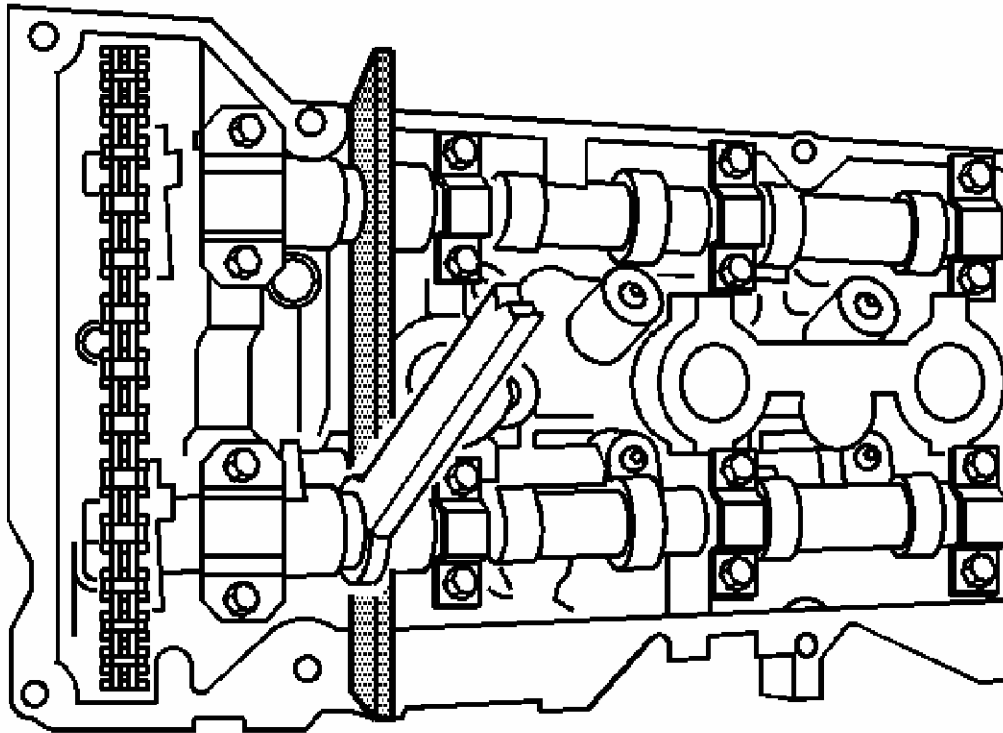


Fig. 217: Securing Camshaft
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Torque Reaction Against Timing Drive Chain Notice .

7. Use an open end wrench on the hex cast into the camshaft in order to prevent the camshaft from rotating when tightening the camshaft sprocket bolt.

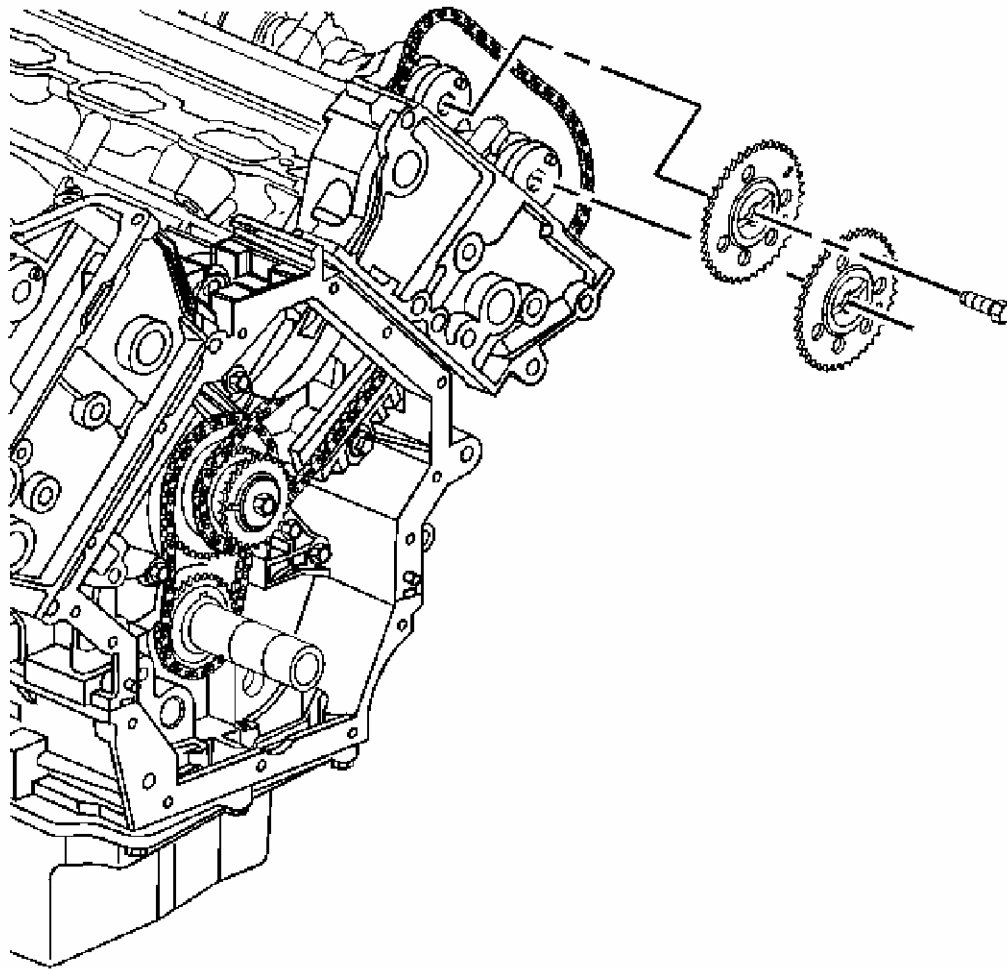


Fig. 218: Identifying Left Exhaust Camshaft Sprocket Bolt
Courtesy of GENERAL MOTORS CORP.

8. Install the left exhaust camshaft sprocket bolt.

Tighten: Tighten the camshaft sprocket bolt to 120 N.m (89 lb ft).

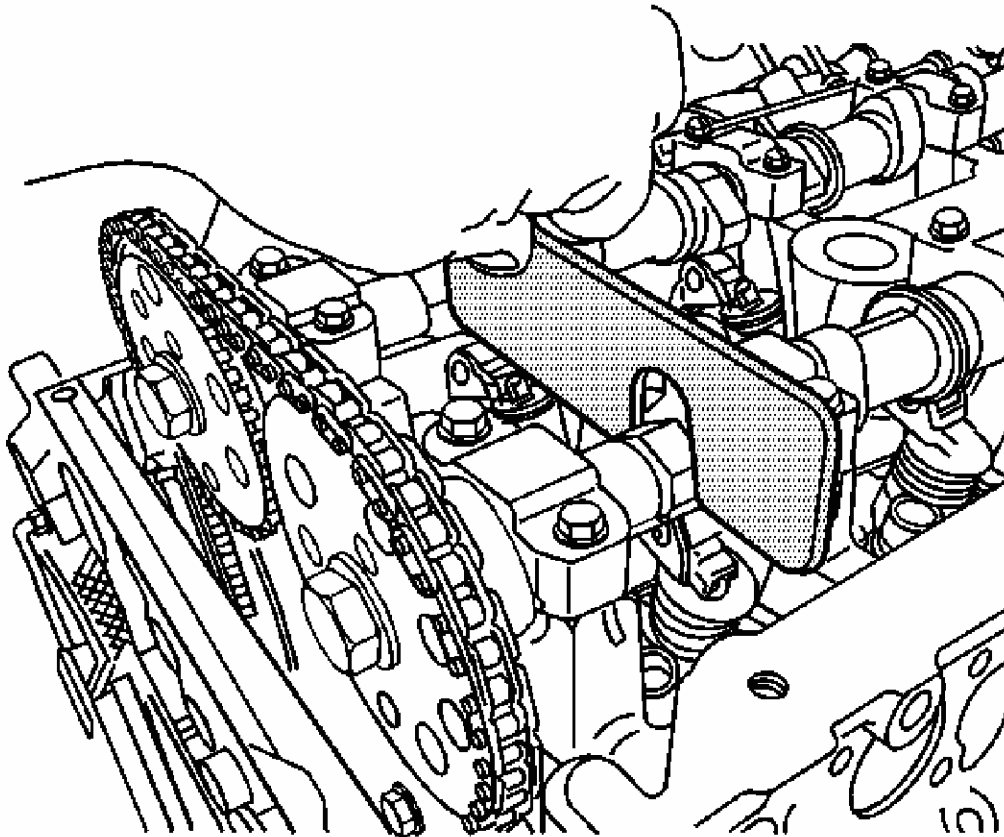


Fig. 219: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS CORP.

9. Remove the **J 44212** from the camshafts. See **Special Tools** .
10. Install the left camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.
11. Install the left secondary camshaft drive chain tensioner. Refer to **Secondary Camshaft Drive Chain Tensioner Replacement - Left Side**.

SECONDARY CAMSHAFT DRIVE CHAIN GUIDE REPLACEMENT - RIGHT SIDE

TOOLS REQUIRED

J 44212 Camshaft Holding Tool. See **Special Tools** .

REMOVAL PROCEDURE

1. Remove the right secondary camshaft drive chain tensioner. Refer to **Secondary Camshaft Drive Chain Tensioner Replacement - Right Side**.
2. Remove the right camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.

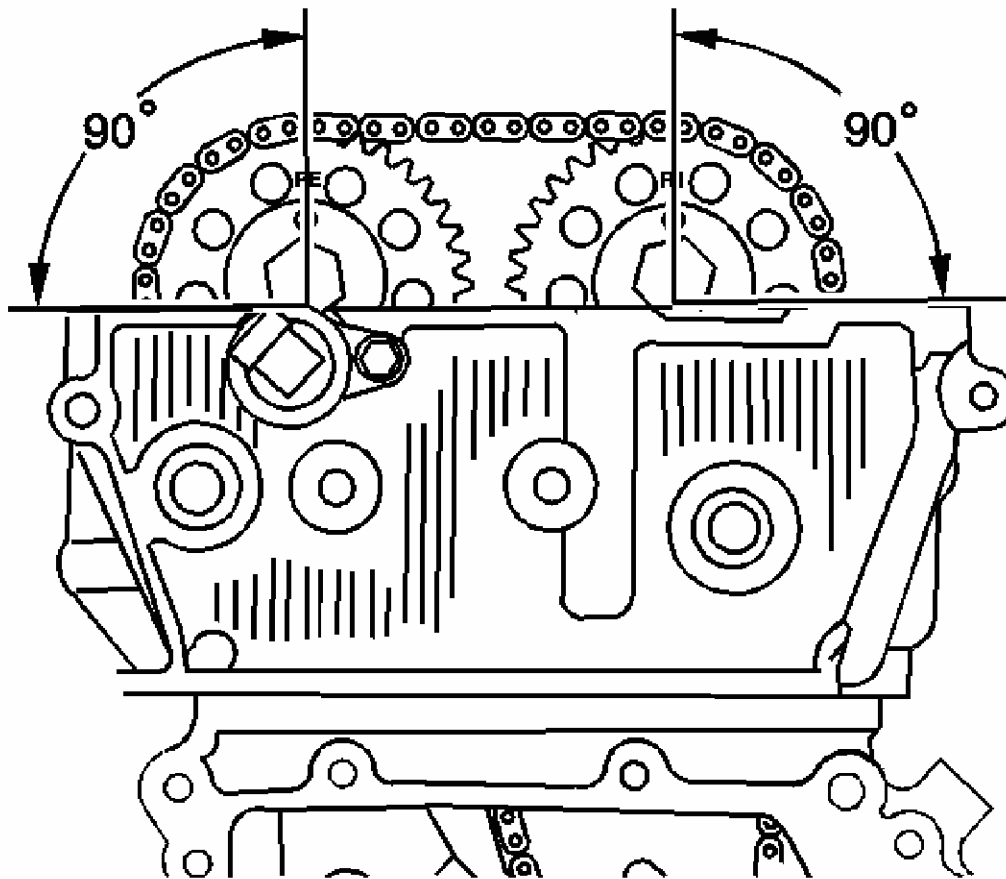


Fig. 220: Ensuring Camshaft Sprocket Drive Pins Are At Top Of Their Rotation
Courtesy of GENERAL MOTORS CORP.

3. Ensure both camshaft sprocket drive pins are at the top of their rotation.

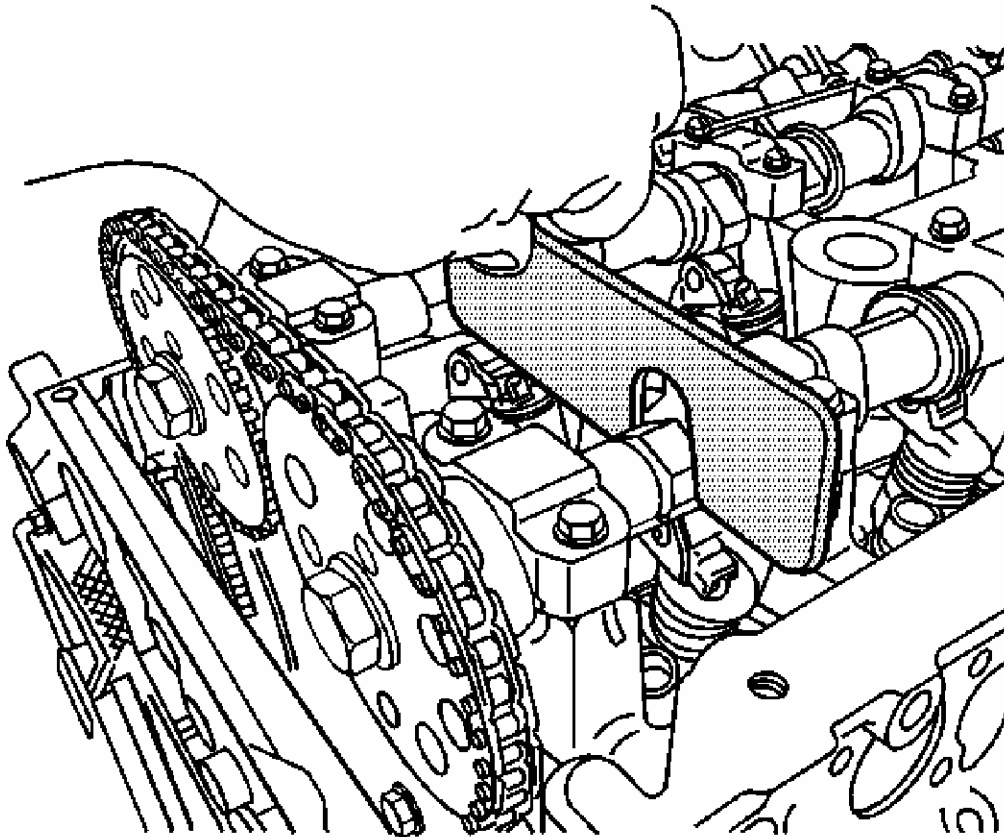


Fig. 221: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Camshaft Holding Tool Caution .

4. Install the **J 44212** over the camshafts. See Special Tools .

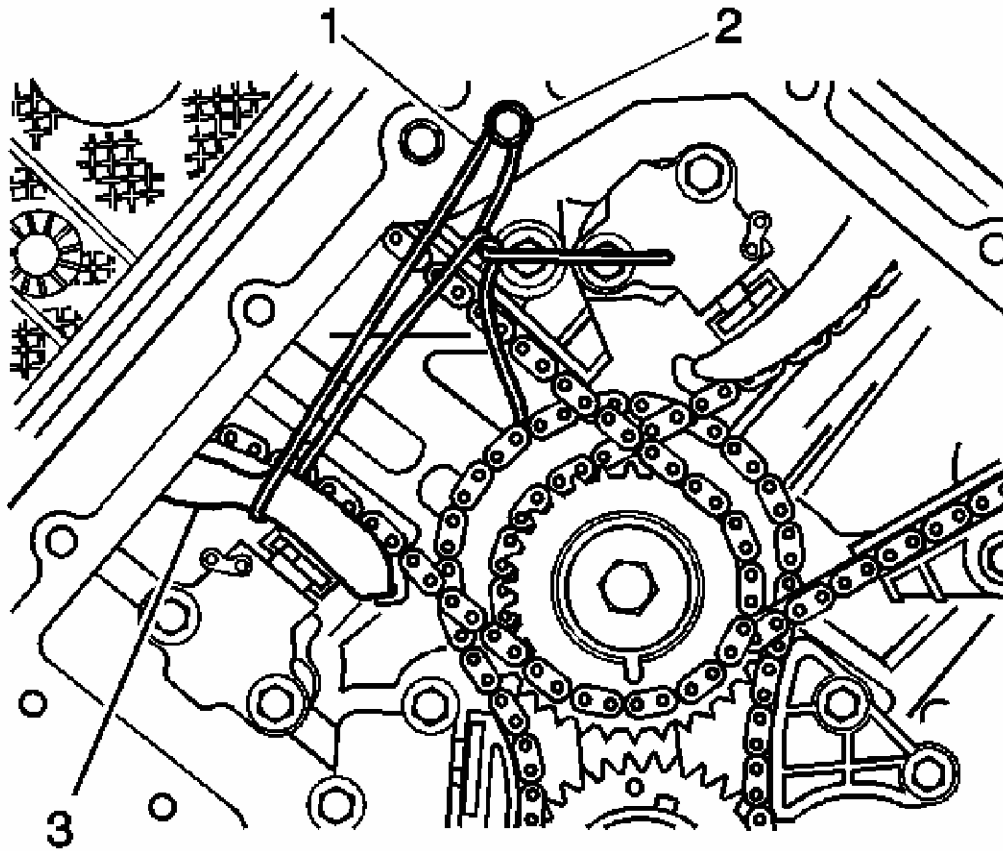


Fig. 222: View Of Mechanics Wire, Right Secondary Camshaft Drive Chain Shoe & Front Cover Bolt

Courtesy of GENERAL MOTORS CORP.

5. Remove the mechanics wire (1) supporting the right secondary camshaft drive chain shoe (3).
6. Remove the engine front cover bolt (2) from the front of the engine.

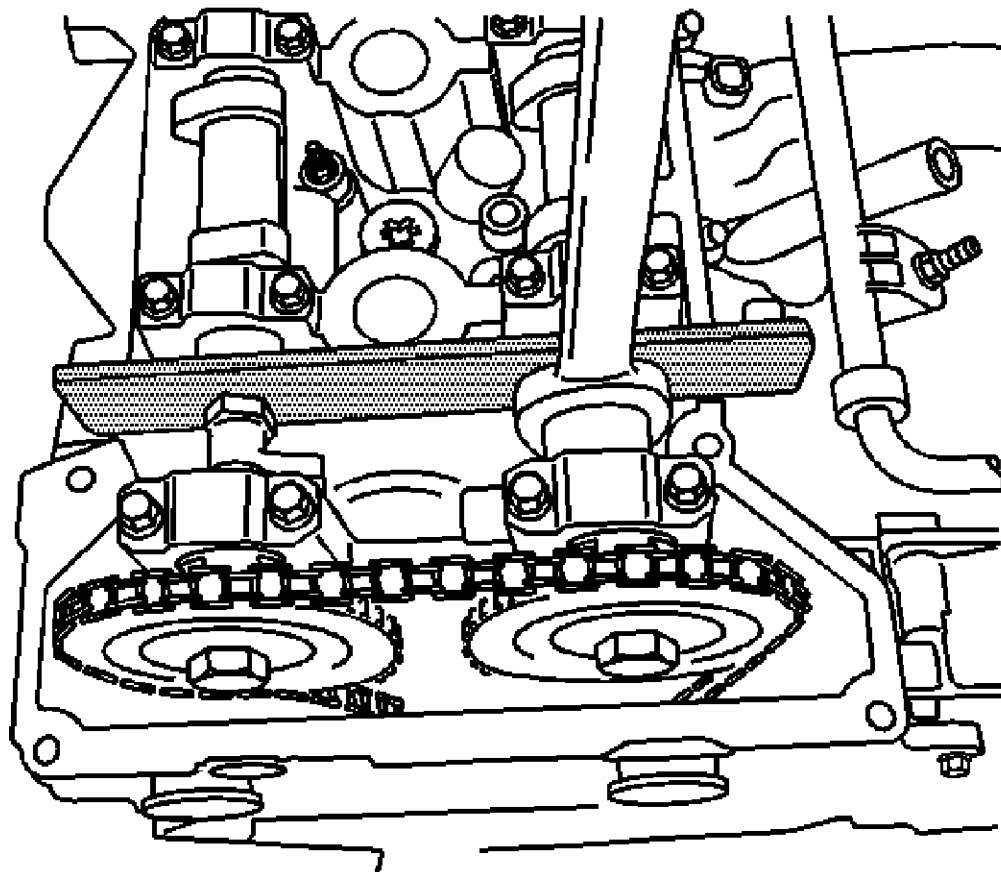


Fig. 223: Securing Camshaft
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Torque Reaction Against Timing Drive Chain Notice .

7. Use an open end wrench on the hex cast into the camshaft in order to prevent the camshaft from rotating when removing the camshaft sprocket bolt.

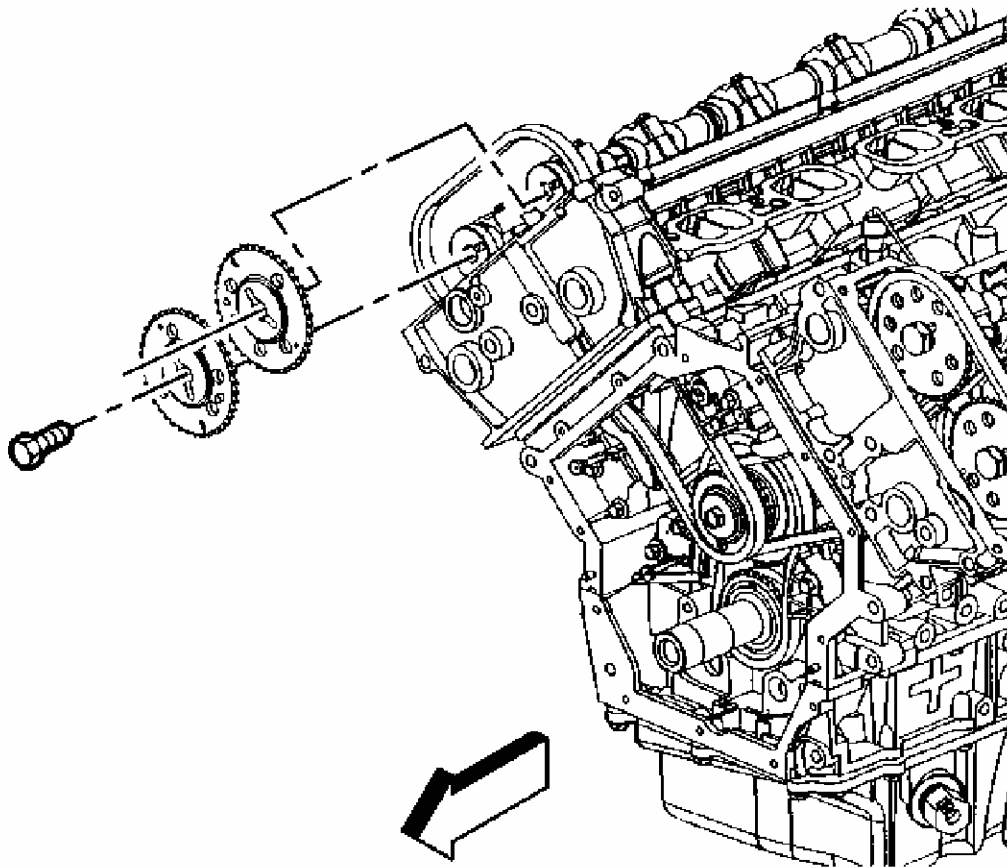


Fig. 224: Identifying Right Intake Camshaft Sprocket Bolt
Courtesy of GENERAL MOTORS CORP.

8. Remove the right intake camshaft sprocket bolt.
9. Slide the right intake camshaft sprocket off of the camshaft and remove the right secondary drive chain from the camshaft sprocket teeth.

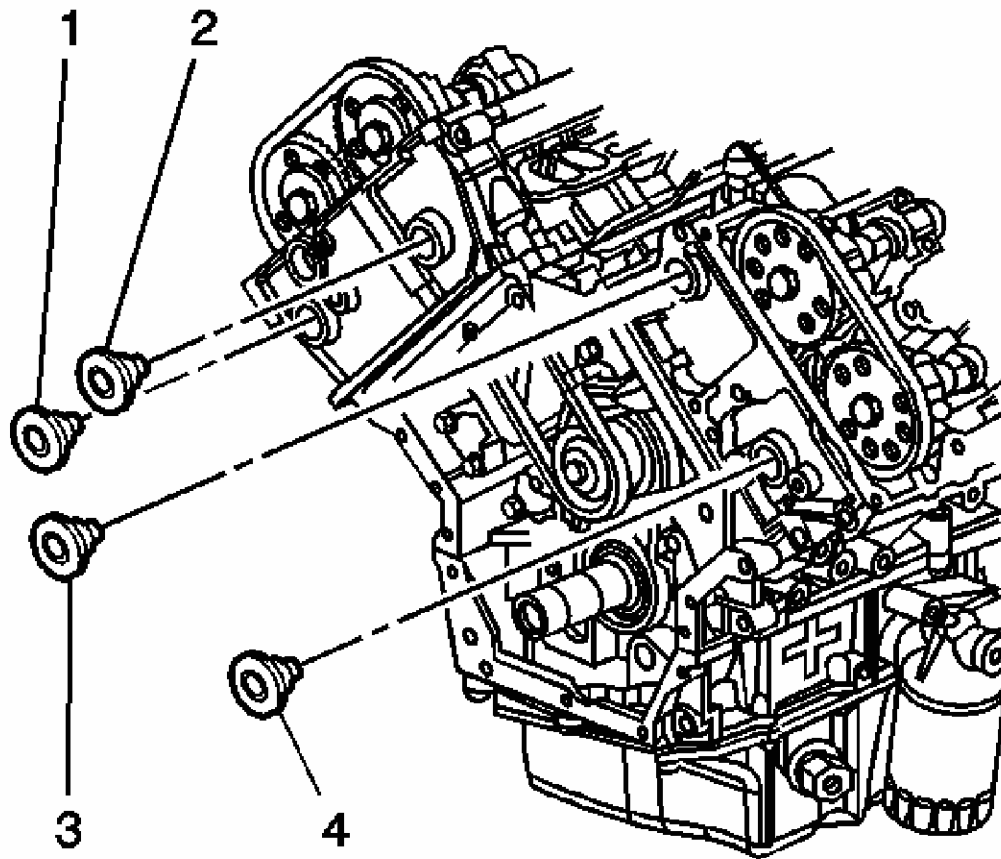


Fig. 225: Locating Camshaft Drive Chain Shoe Access Plugs On Front Of Engine
Courtesy of GENERAL MOTORS CORP.

10. Remove the right secondary camshaft drive chain guide access plug (2) located in the cylinder head. Ensure the O-ring seal remains attached to the access plug.

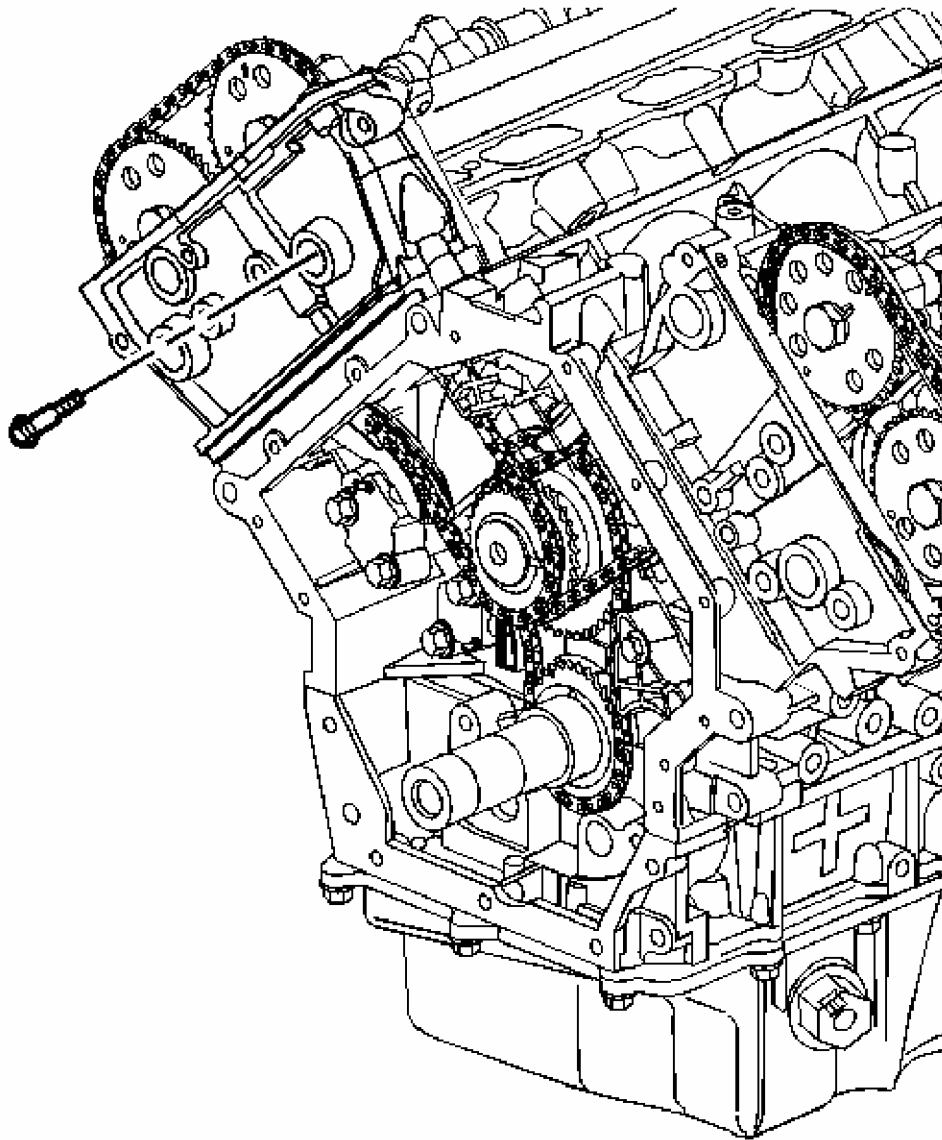


Fig. 226: View Of Upper Right Secondary Camshaft Drive Chain Guide Bolt
Courtesy of GENERAL MOTORS CORP.

11. Remove the upper right secondary camshaft drive chain guide bolt.

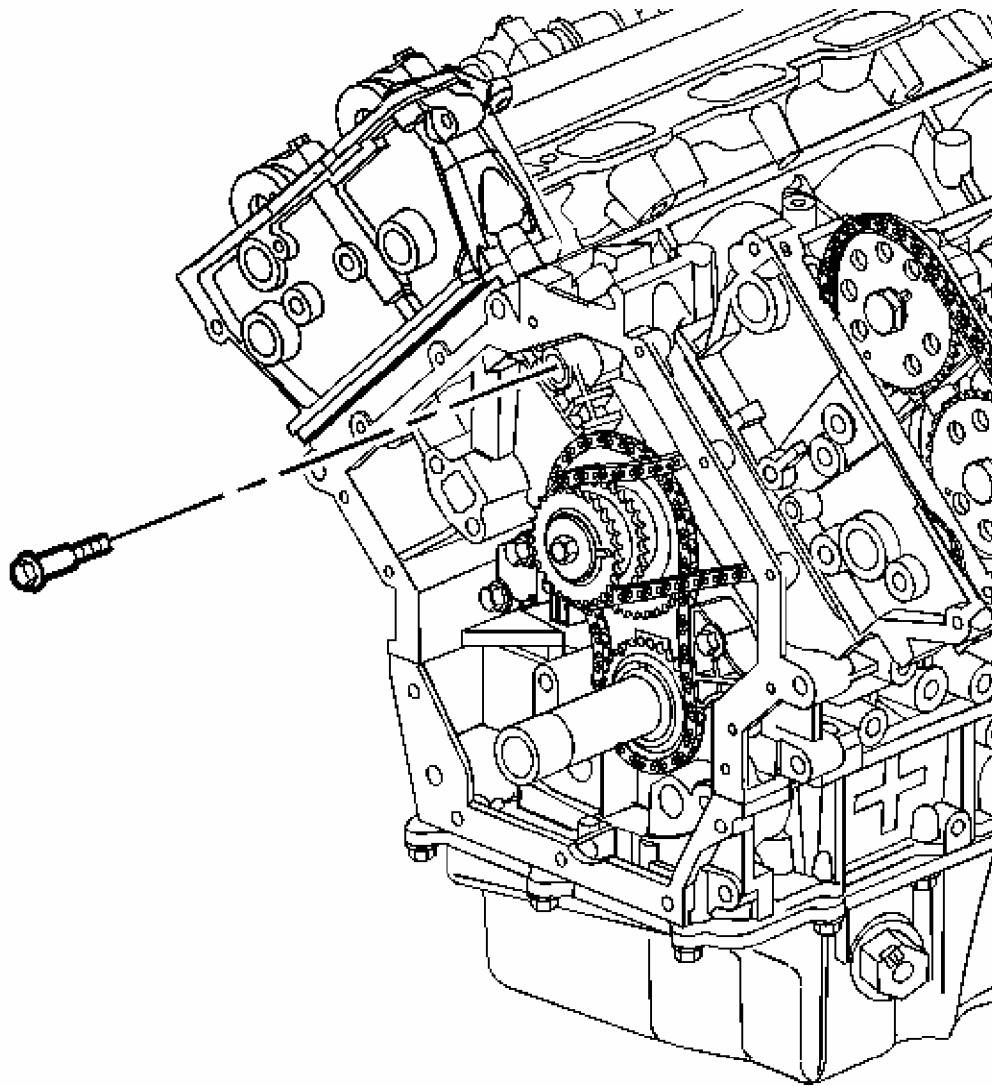


Fig. 227: Identifying Lower Right Secondary Camshaft Drive Chain Guide Bolt
Courtesy of GENERAL MOTORS CORP.

12. Remove the lower right secondary camshaft drive chain guide bolt.

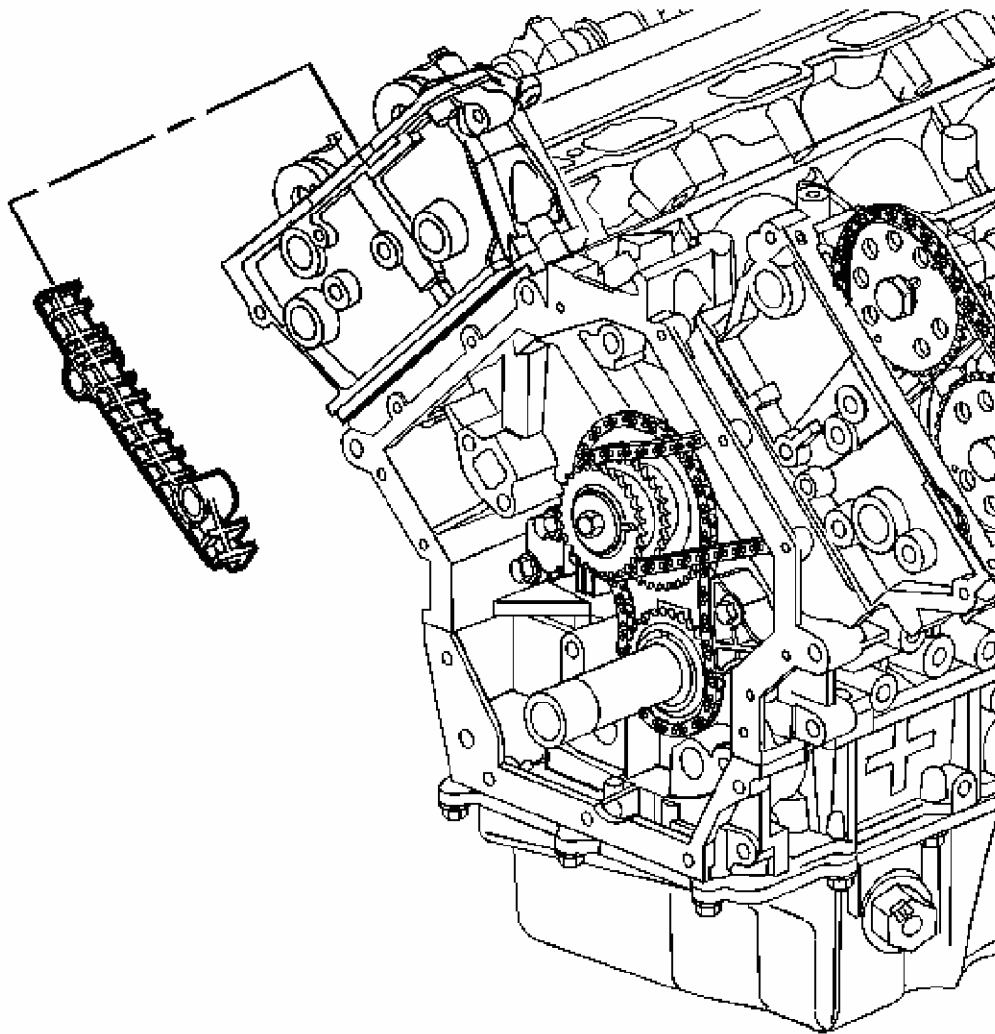


Fig. 228: View of Right Secondary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS CORP.

13. Remove the right secondary camshaft drive chain guide.
14. Clean and inspect the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** .

INSTALLATION PROCEDURE

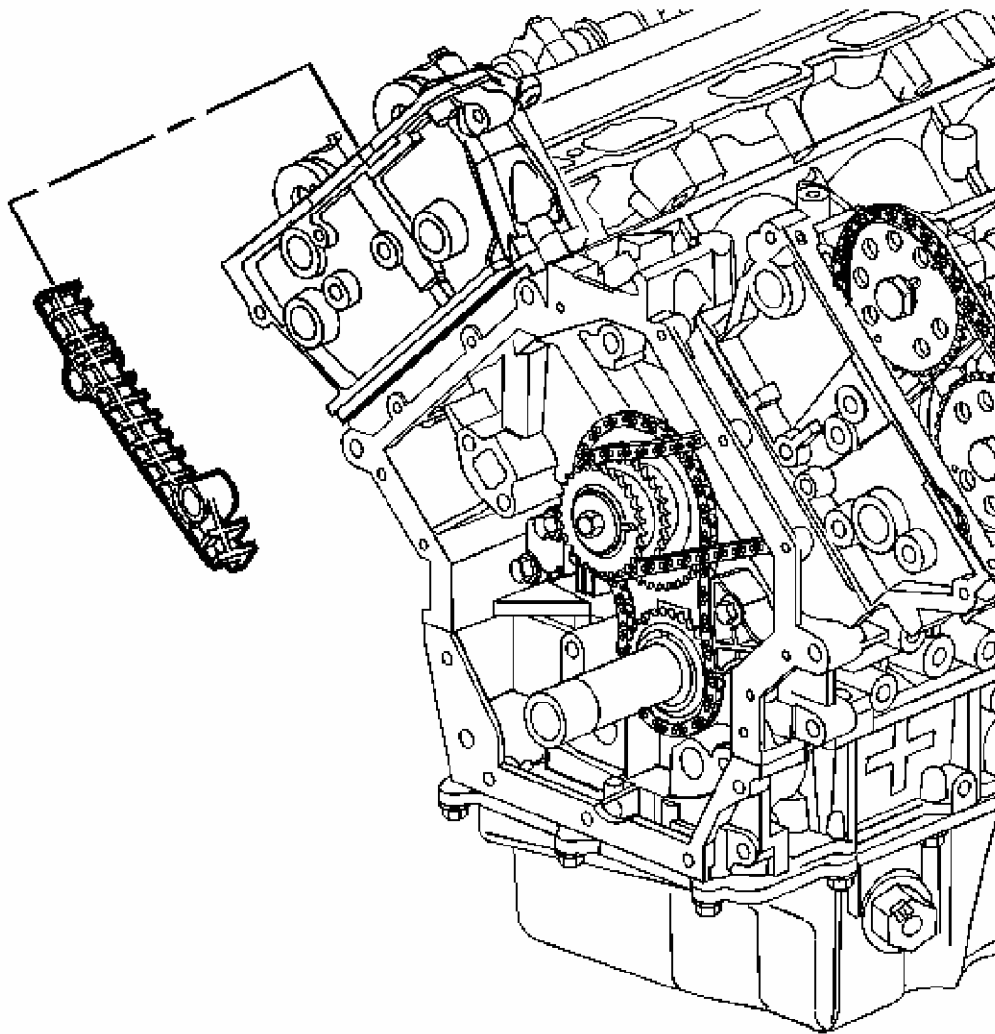


Fig. 229: View of Right Secondary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS CORP.

1. Position the right secondary camshaft drive chain guide in through the top of the cylinder head.

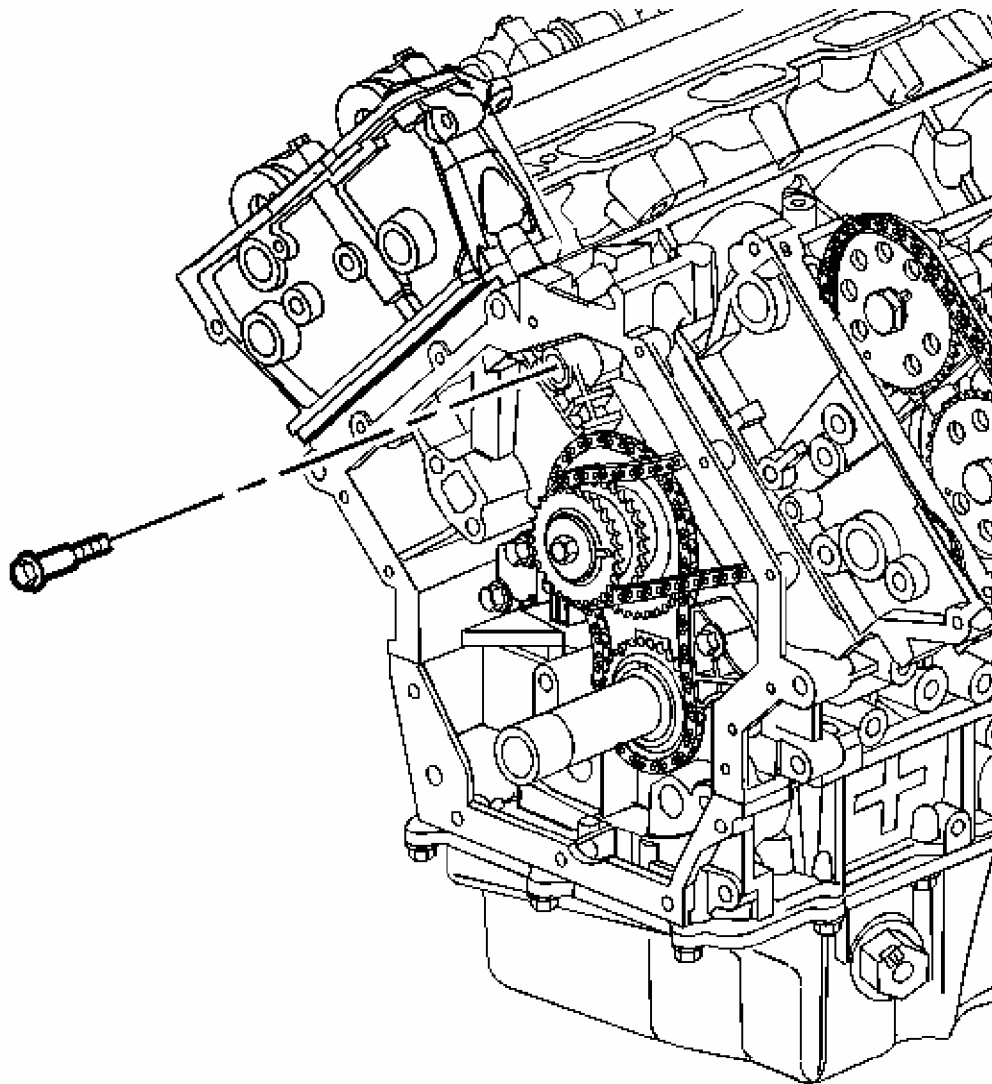


Fig. 230: Identifying Lower Right Secondary Camshaft Drive Chain Guide Bolt
Courtesy of GENERAL MOTORS CORP.

2. Loosely install the lower right secondary camshaft drive chain guide bolt.

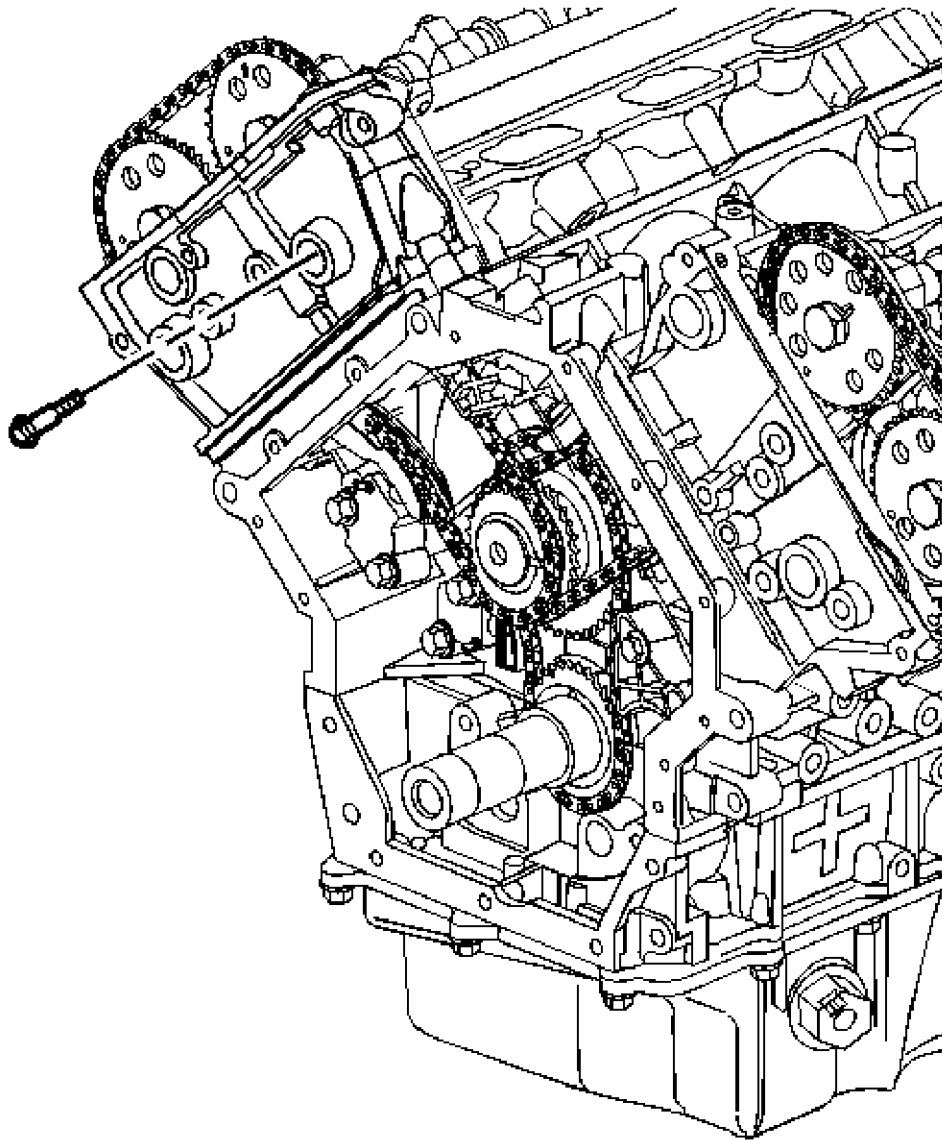


Fig. 231: View Of Upper Right Secondary Camshaft Drive Chain Guide Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE .

3. Install the upper right secondary camshaft drive chain guide bolt.

Tighten: Tighten the secondary camshaft drive chain guide bolts to 25 N.m (18 lb ft).

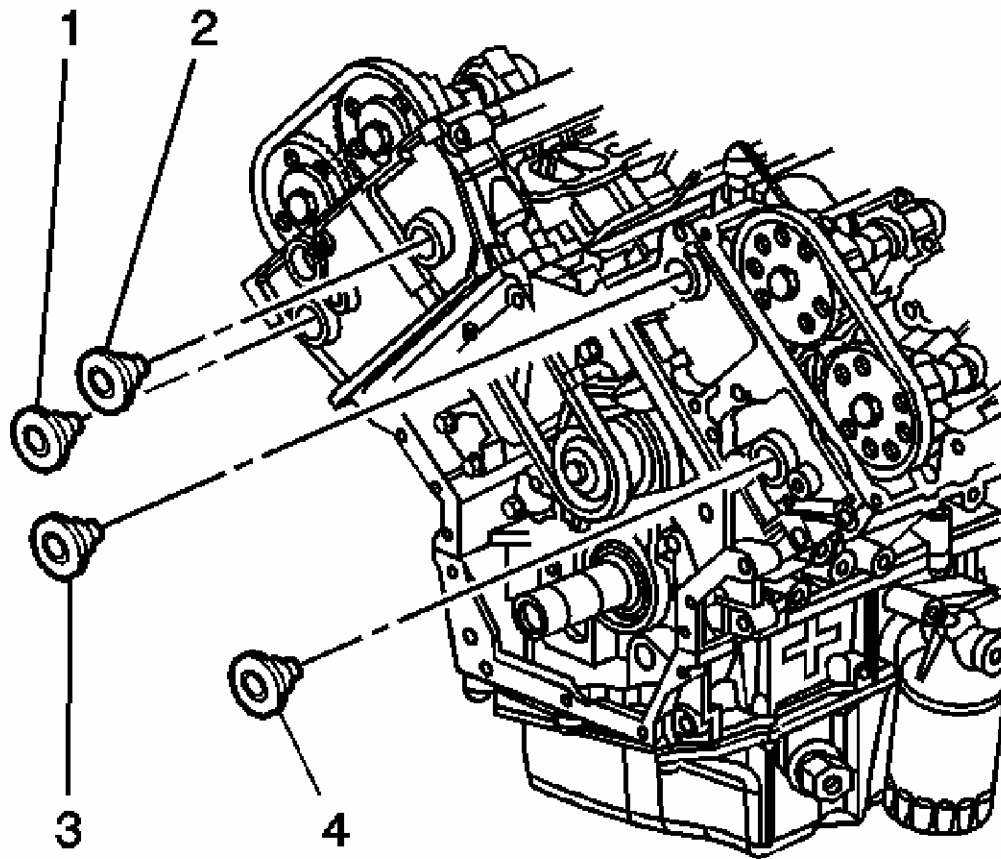


Fig. 232: Locating Camshaft Drive Chain Shoe Access Plugs On Front Of Engine
Courtesy of GENERAL MOTORS CORP.

4. Install the right secondary camshaft drive chain guide access plug (2) located in the cylinder head. Ensure the O-ring seal is attached to the access plug.

Tighten: Tighten the secondary camshaft drive chain guide access plug to 4.5 N.m (40 lb in).

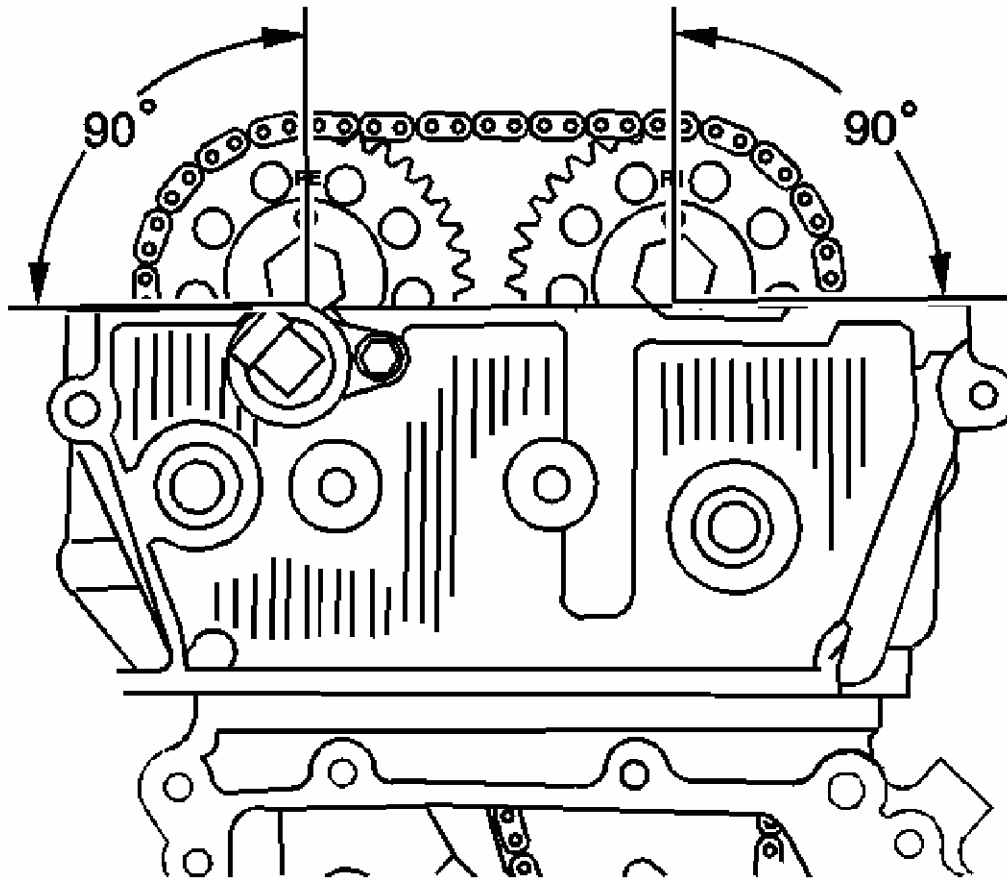


Fig. 233: Ensuring Camshaft Sprocket Drive Pins Are At Top Of Their Rotation
Courtesy of GENERAL MOTORS CORP.

5. Install the right intake camshaft sprocket into the right secondary camshaft drive chain.
6. Install the right intake camshaft sprocket onto the camshaft. The camshaft sprocket notch marked RI (right intake) engages the intake camshaft pin.

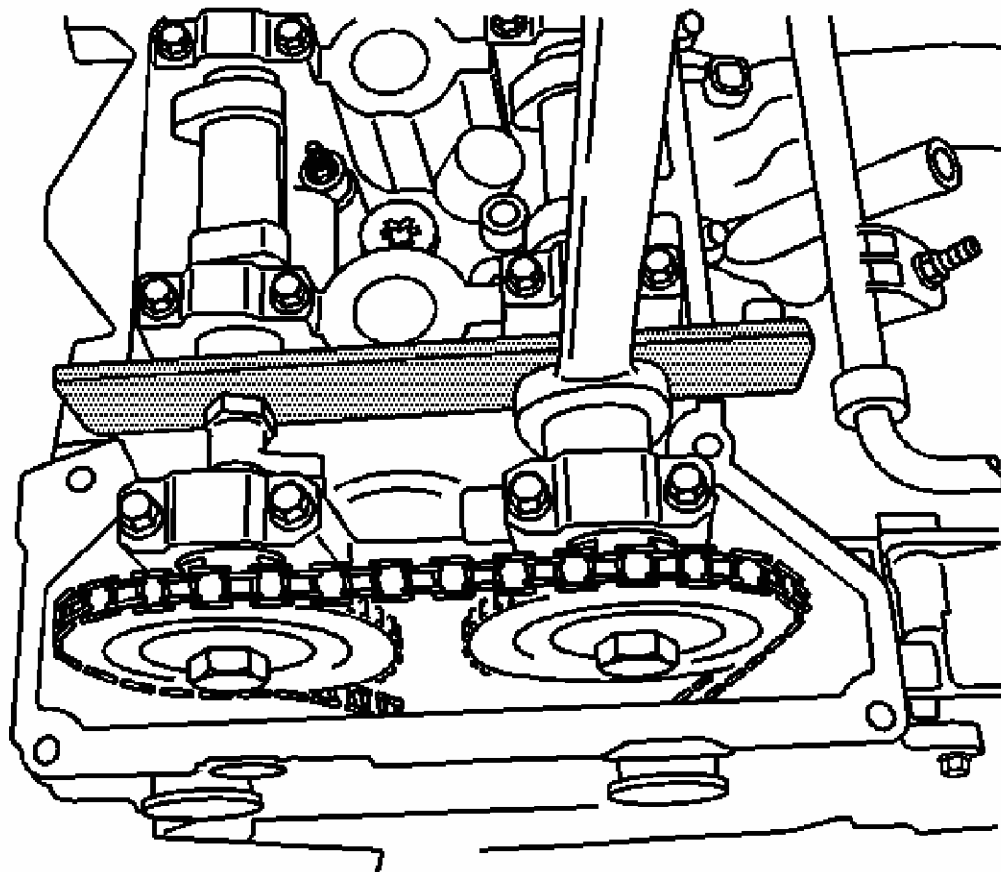


Fig. 234: Securing Camshaft
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Torque Reaction Against Timing Drive Chain Notice .

7. Use an open end wrench on the hex cast into the camshaft in order to prevent the camshaft from rotating when tightening the camshaft sprocket bolt.

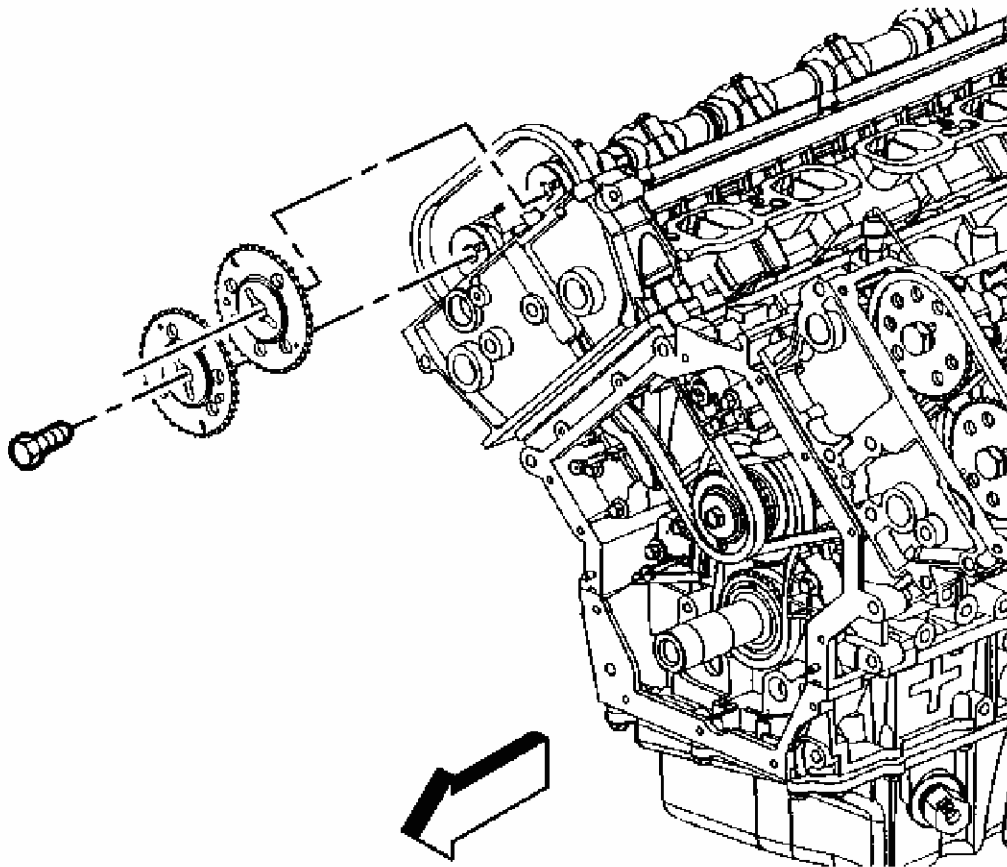


Fig. 235: Identifying Right Intake Camshaft Sprocket Bolt
Courtesy of GENERAL MOTORS CORP.

8. Install the right intake camshaft sprocket bolt.

Tighten: Tighten the camshaft sprocket bolt to 120 N.m (89 lb ft).

9. Install the right secondary camshaft drive chain tensioner. Refer to **Secondary Camshaft Drive Chain Tensioner Replacement - Right Side.**

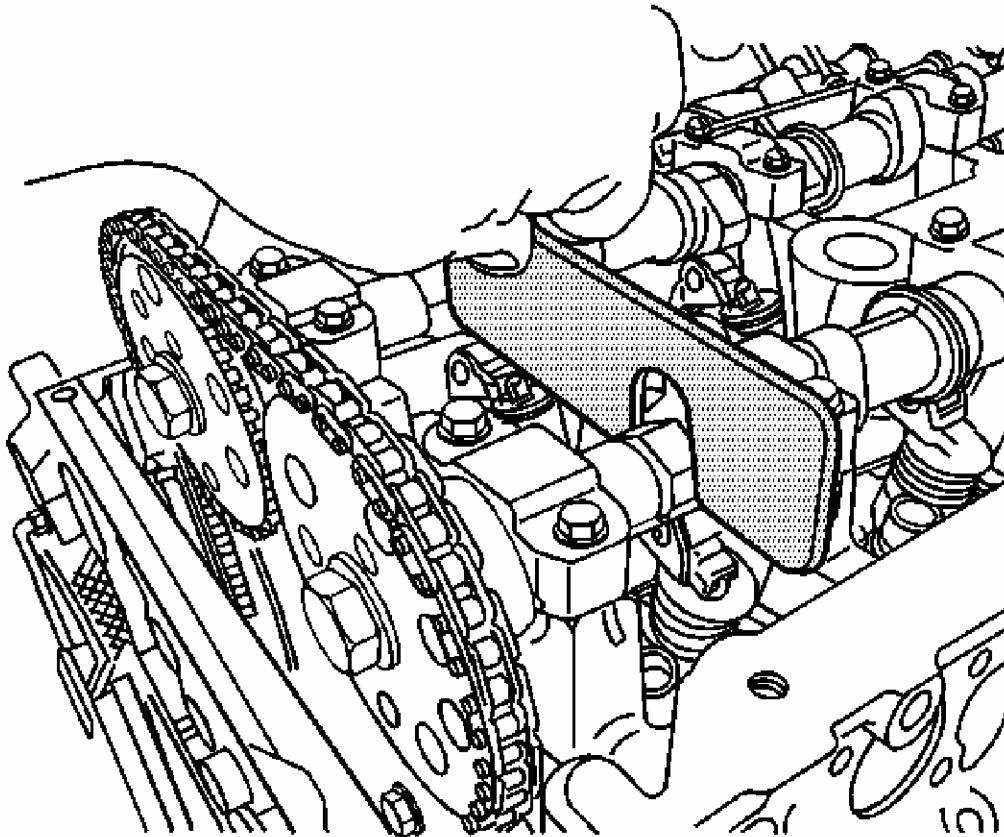


Fig. 236: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS CORP.

10. Remove the **J 44212** from the camshafts. See **Special Tools** .
11. Install the right camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.

PRIMARY CAMSHAFT DRIVE CHAIN TENSIONER REPLACEMENT

TOOLS REQUIRED

J 39946 Crankshaft Socket - 4. See **Special Tools** .0L and 4.6L

REMOVAL PROCEDURE

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.

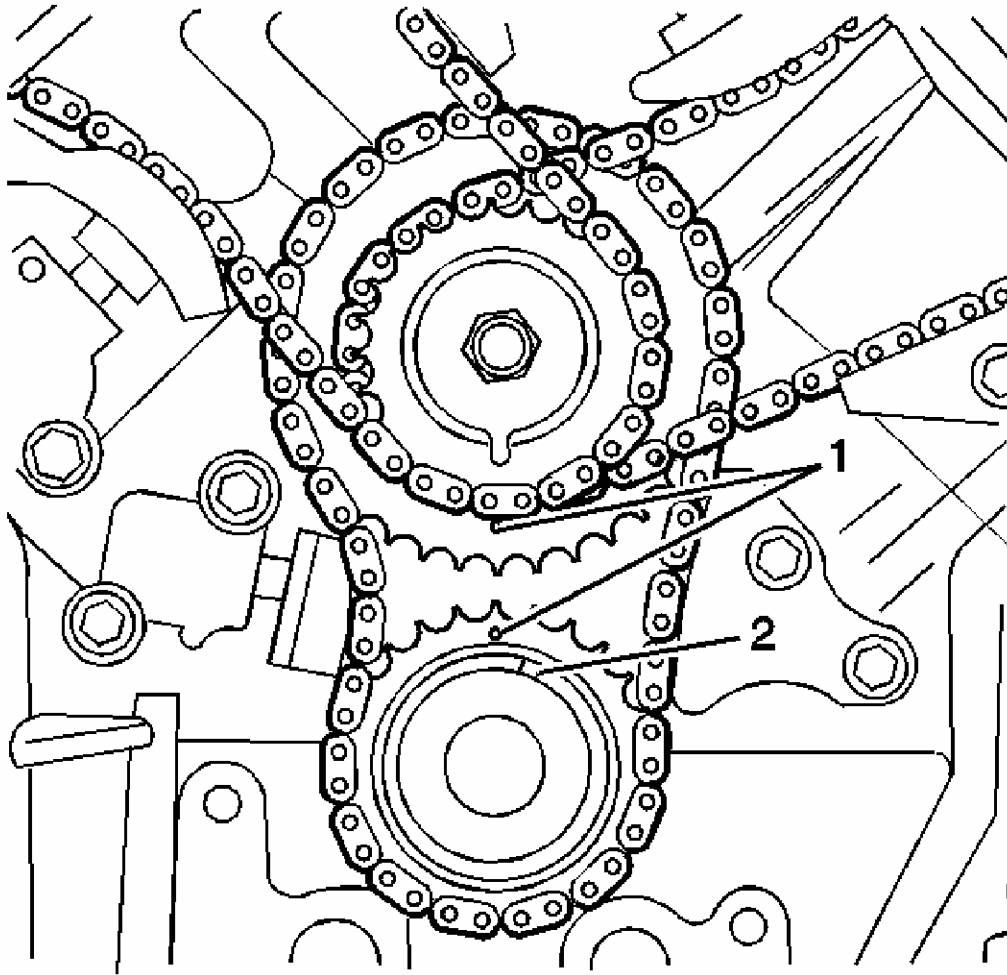


Fig. 237: Identifying Primary Timing Gear Alignment Marks
Courtesy of GENERAL MOTORS CORP.

2. Align the primary timing marks (1) using the J 39946 . See **Special Tools** .

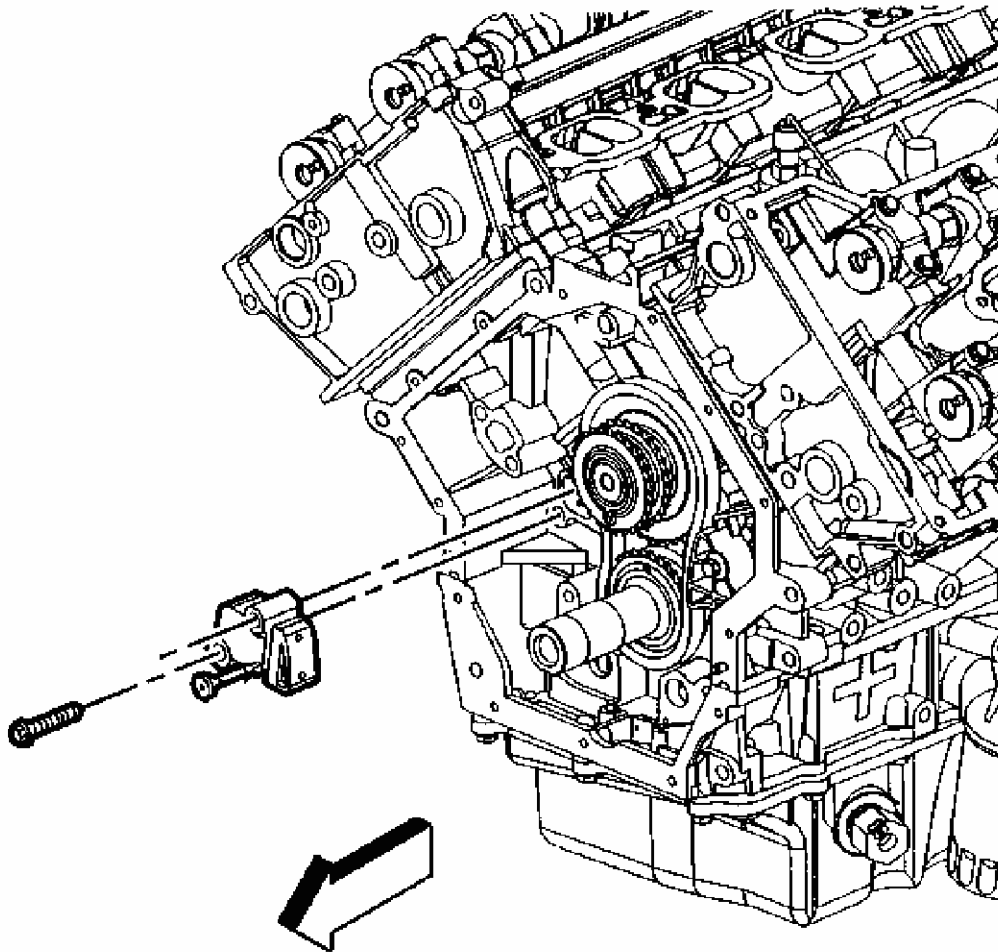


Fig. 238: Locating Primary Camshaft Drive Chain Tensioner & Bolts
Courtesy of GENERAL MOTORS CORP.

3. Remove the 2 bolts attaching the primary camshaft drive chain tensioner to the engine block.
4. Remove the primary camshaft drive chain tensioner, allowing the tensioner to expand as you remove it.
5. Clean and inspect the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** .

INSTALLATION PROCEDURE

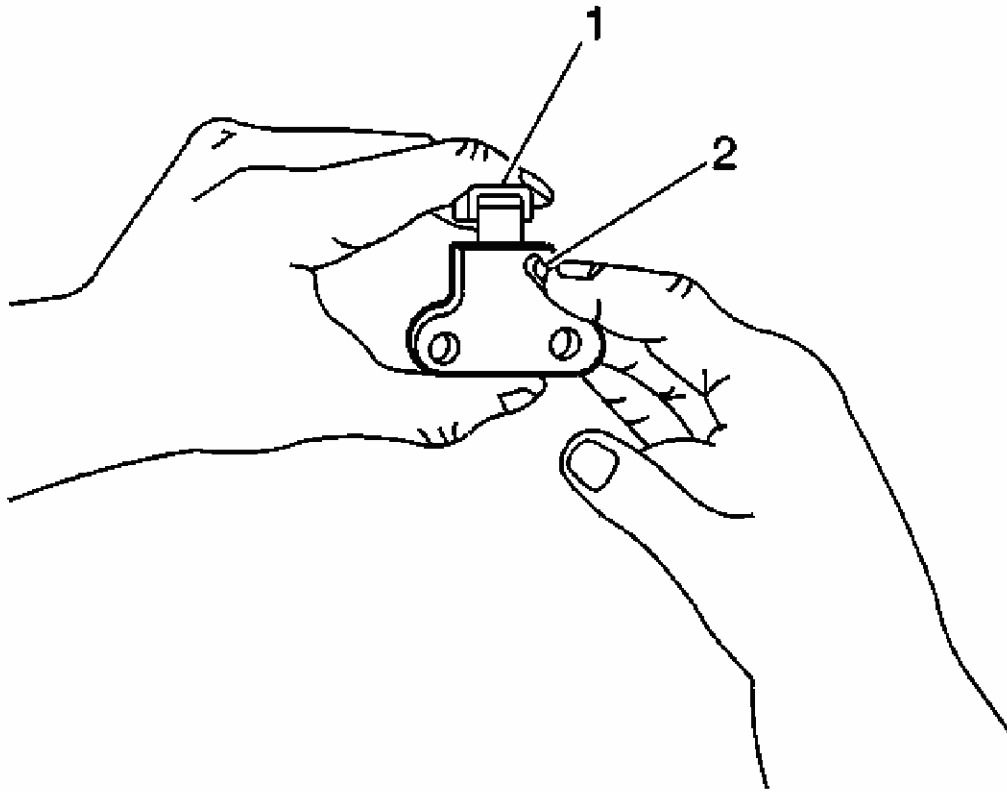


Fig. 239: View Of Primary Camshaft Drive Chain Tensioner Shoe & Ratchet Lever

Courtesy of GENERAL MOTORS CORP.

1. Collapse the primary camshaft drive chain tensioner using the following procedure:
 1. Rotate the ratchet release lever (2) clockwise and hold.
 2. Collapse the tensioner shoe (1) and hold.
 3. Release the ratchet lever (2).
2. Slowly release the pressure on the shoe (1), until the ratchet lever (2) moves to the first detent and a "click" is heard and felt.
3. Collapse the tensioner shoe (1) and hold.

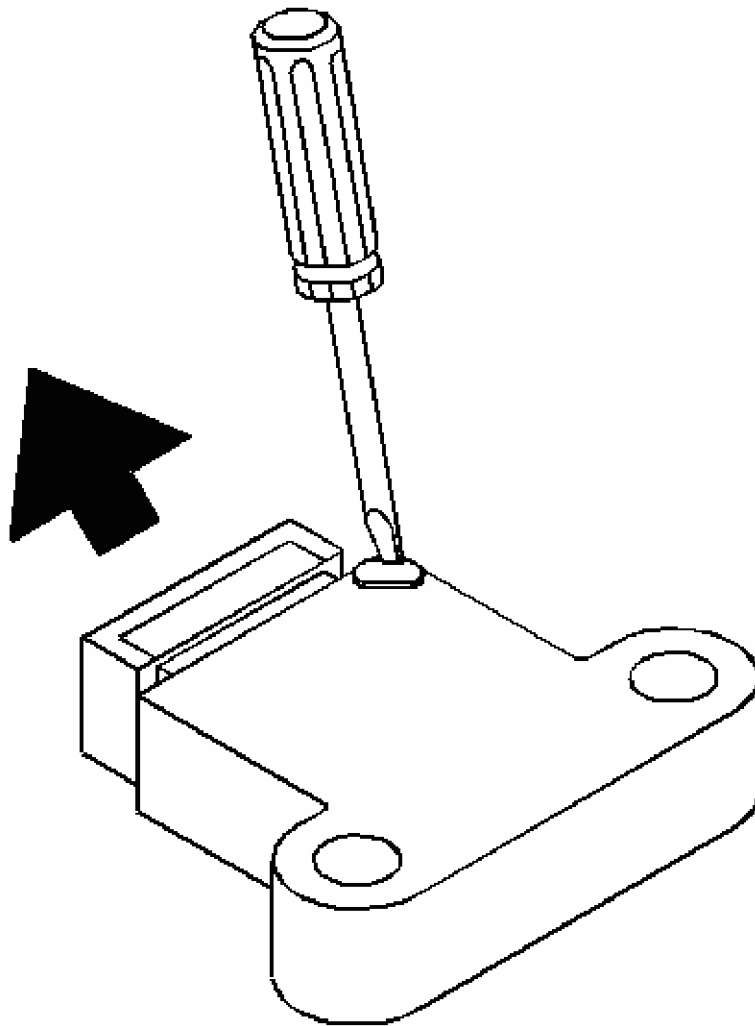


Fig. 240: Locking Primary Camshaft Drive Chain Tensioner Shoe Into Collapsed Position

Courtesy of GENERAL MOTORS CORP.

4. Insert a pin through the hole in the release lever in order to lock the tensioner shoe in the collapsed position.

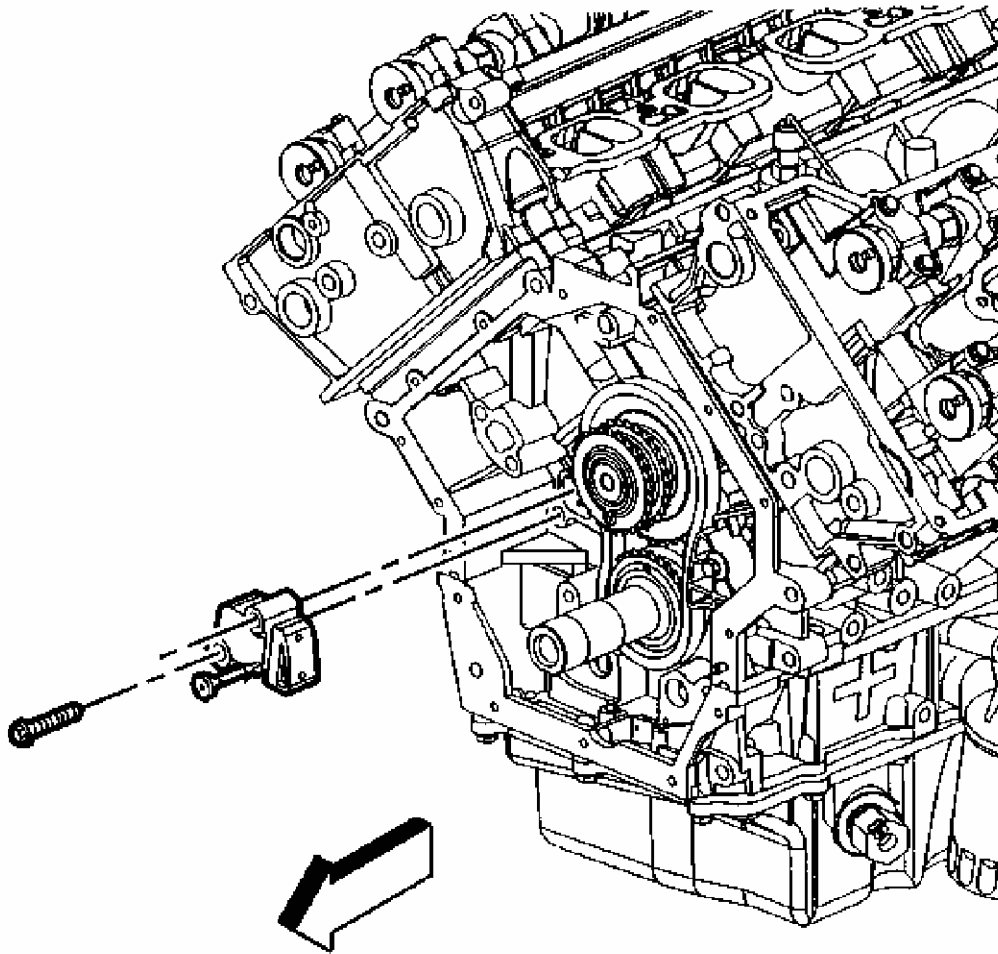


Fig. 241: Locating Primary Camshaft Drive Chain Tensioner & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE .

IMPORTANT: Ensure the tensioner release lever is facing outward.

5. Install the primary camshaft drive chain tensioner and retaining bolts.

Tighten: Tighten the primary camshaft drive chain tensioner bolts to 25 N.m (18 lb ft).

6. Remove the pin holding the tensioner to tighten any slack in the timing chain.

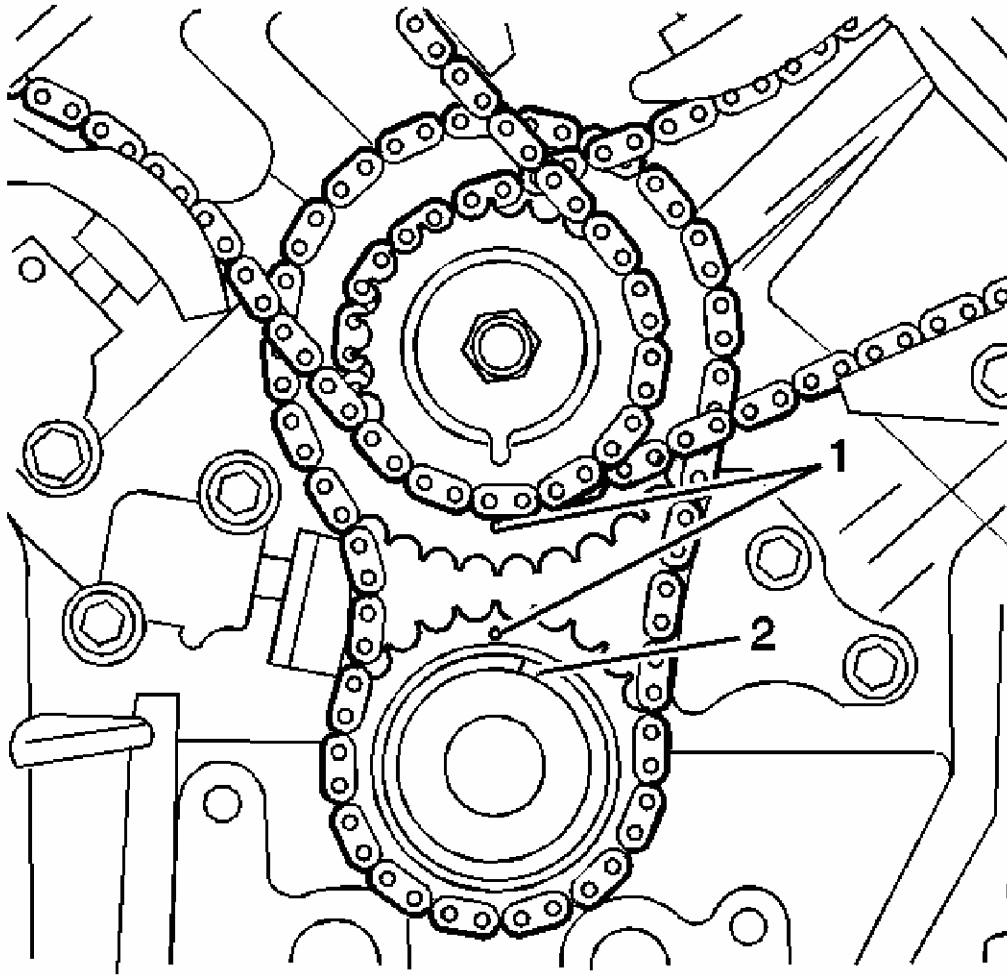


Fig. 242: Identifying Primary Timing Gear Alignment Marks
Courtesy of GENERAL MOTORS CORP.

7. Ensure the primary timing marks (1) are aligned vertically.
8. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

PRIMARY CAMSHAFT DRIVE CHAIN GUIDE REPLACEMENT

REMOVAL PROCEDURE

1. Remove the front cover. Refer to **Engine Front Cover Replacement**.

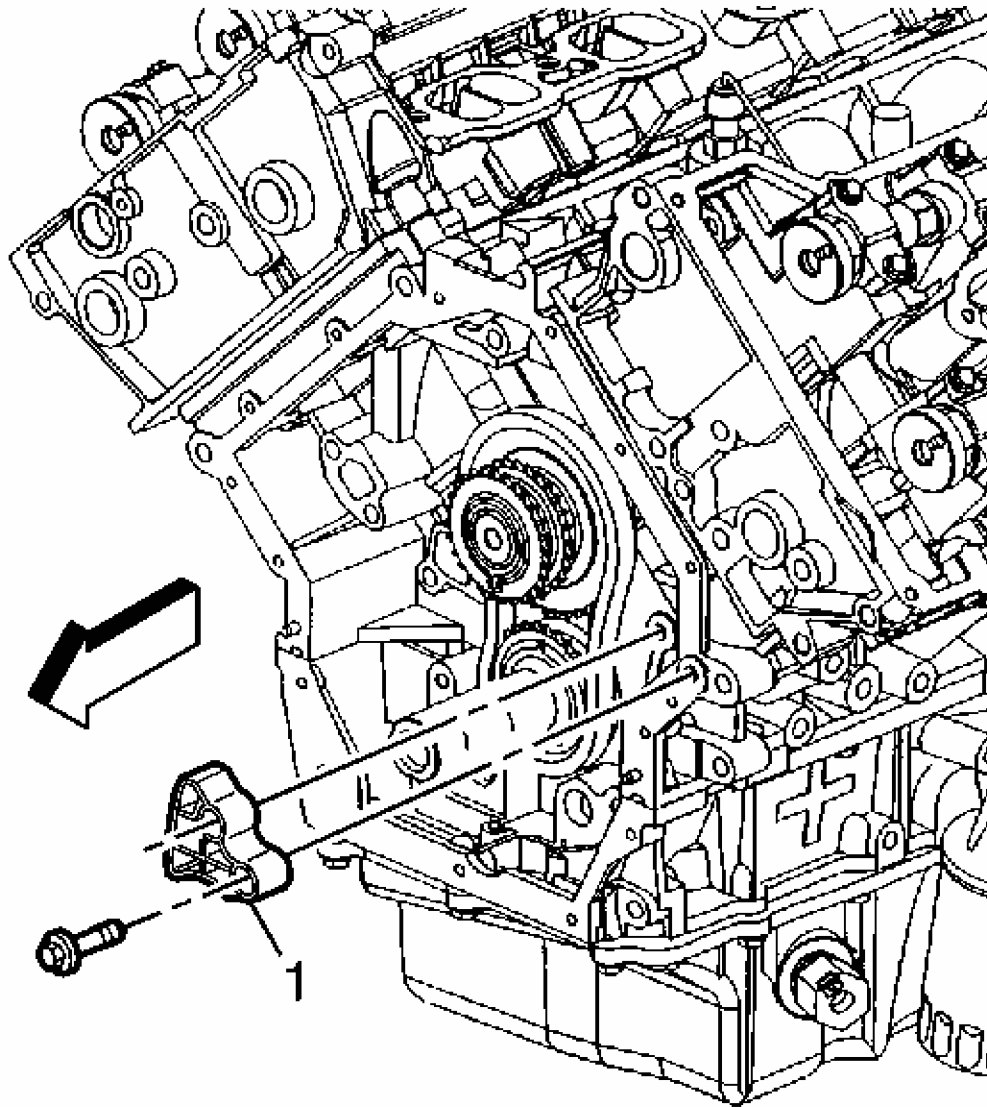


Fig. 243: Locating Primary Camshaft Drive Chain Guide & Bolts
Courtesy of GENERAL MOTORS CORP.

2. Remove the two bolts attaching the primary camshaft drive chain guide (1) to the engine block.
3. Remove the primary camshaft drive chain guide (1).
4. Clean and inspect the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** .

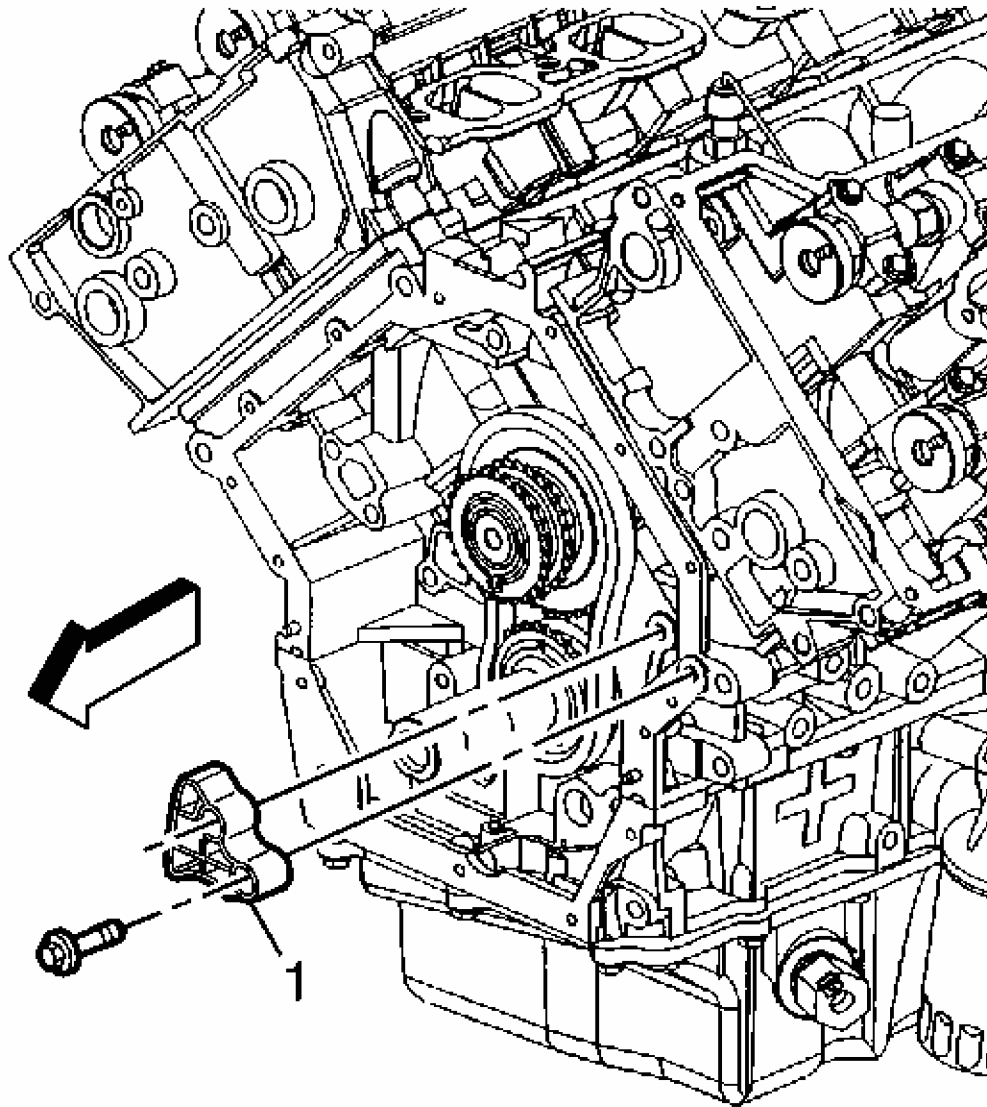


Fig. 244: Locating Primary Camshaft Drive Chain Guide & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE .

1. Install the primary camshaft drive chain guide (1) and retaining bolts.

Tighten: Tighten the primary camshaft drive chain guide bolts to 25 N.m (18 lb ft).

2. Install the front cover. Refer to Engine Front Cover Replacement.

PRIMARY CAMSHAFT DRIVE CHAIN AND SPROCKETS REPLACEMENT

TOOLS REQUIRED

J 39946 Crankshaft Socket - 4. See Special Tools .0L and 4.6L

REMOVAL PROCEDURE

1. Remove the oil pump. Refer to Oil Pump Replacement.

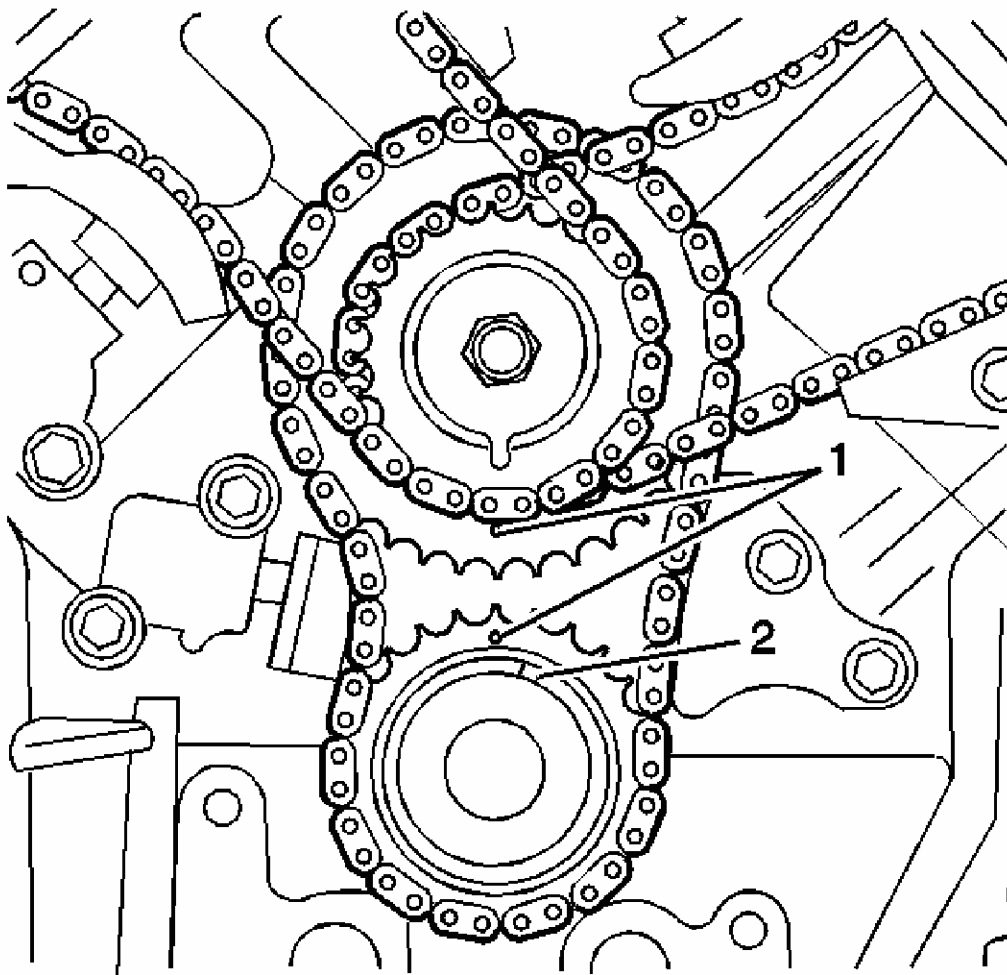


Fig. 245: Identifying Primary Timing Gear Alignment Marks
Courtesy of GENERAL MOTORS CORP.

2. Align the primary timing marks (1) using the **J 39946** . See Special Tools .
3. Remove the secondary camshaft drive chains. Refer to **Secondary Camshaft Drive**

Chain Replacement - Right Side and Secondary Camshaft Drive Chain Replacement - Left Side.

4. Remove the primary drive chain tensioner. Refer to **Primary Camshaft Drive Chain Tensioner Replacement**.

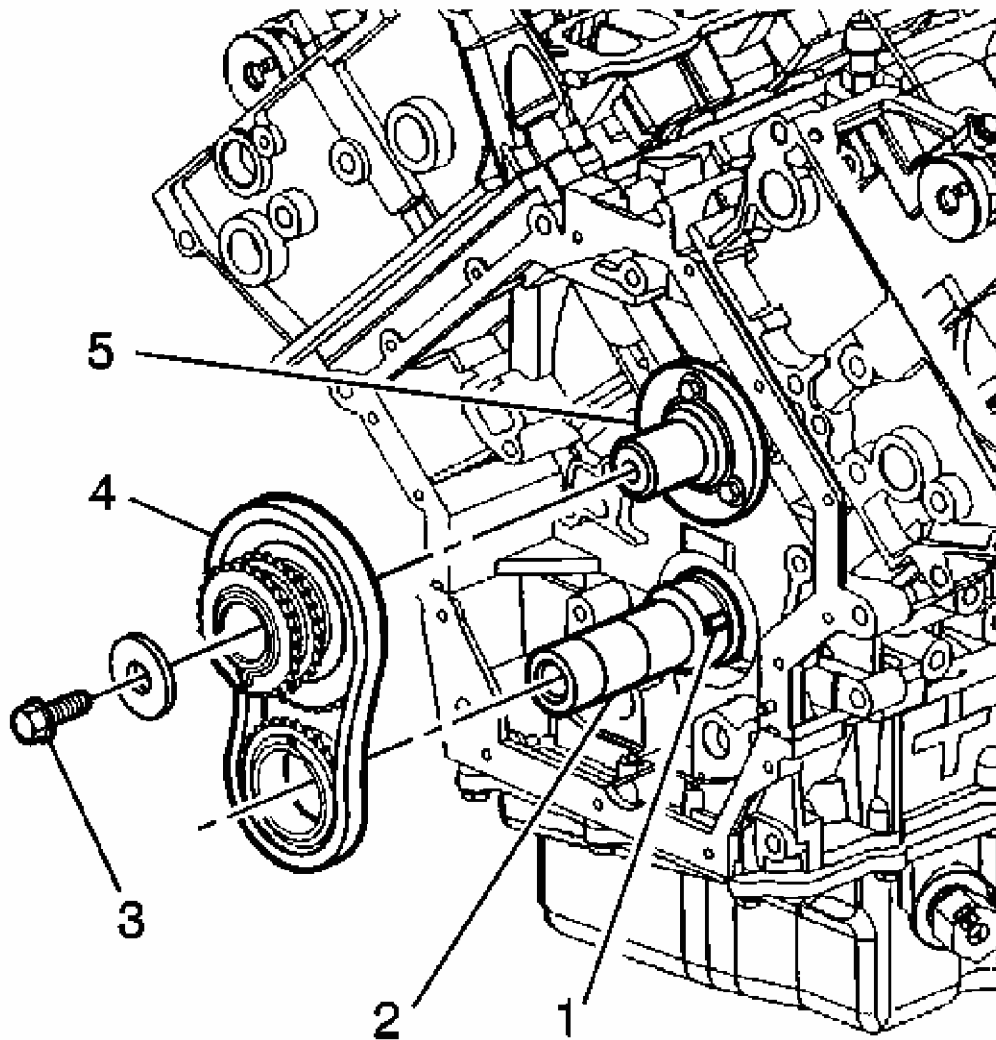


Fig. 246: Identifying Camshaft Intermediate Sprocket Retaining Bolt & Camshaft Drive Chain
Courtesy of GENERAL MOTORS CORP.

5. Remove the camshaft intermediate sprocket retaining bolt (3).
6. Remove the following as an assembly:
 - The primary camshaft drive chain (4)

- The crankshaft sprocket
 - The camshaft intermediate sprocket
7. Clean and inspect the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** .

INSTALLATION PROCEDURE

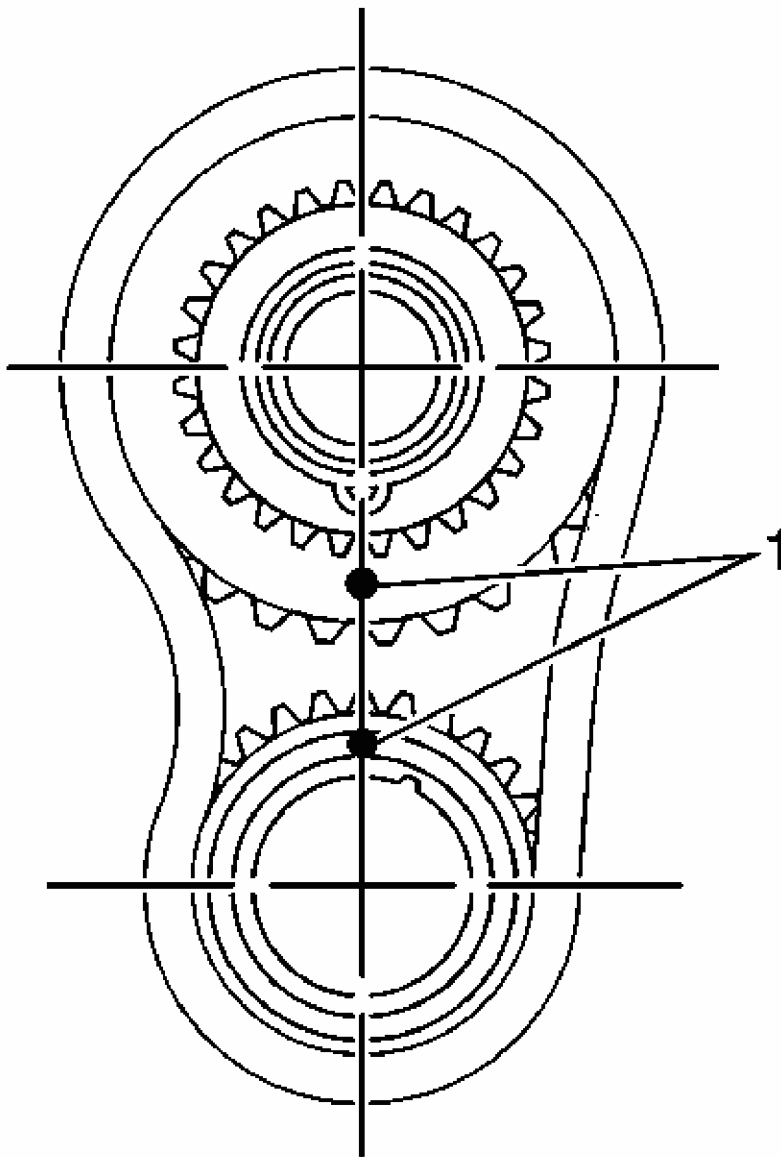


Fig. 247: Aligning Timing Marks Of Camshaft Intermediate & Crankshaft

Sprockets**Courtesy of GENERAL MOTORS CORP.**

1. Align the timing marks (1) of the camshaft intermediate and crankshaft sprockets. The marks should be aligned vertically in the installed position.
2. Install the primary camshaft drive chain on the drive sprockets.
3. Make sure that the number 1 piston is at top dead center (TDC) and the crankshaft keyway is approximately at the 1 o'clock position.

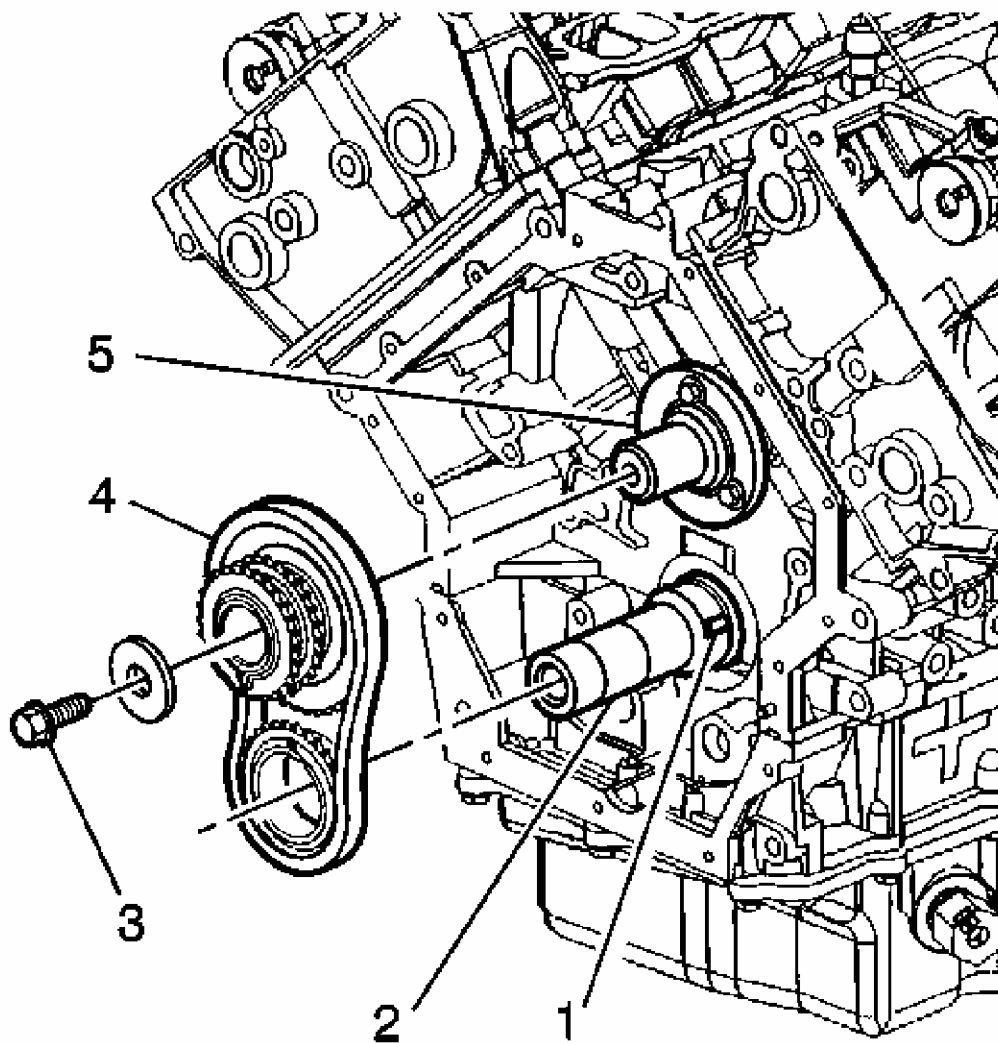


Fig. 248: Identifying Camshaft Intermediate Sprocket Retaining Bolt & Camshaft Drive Chain

Courtesy of GENERAL MOTORS CORP.

4. Use the **J 39946** to align the crankshaft key (1) with the drive sprocket. See **Special Tools** .
5. Install the following as an assembly:
 - The primary camshaft drive chain (4)
 - The crankshaft sprocket
 - The camshaft intermediate sprocket

NOTE: Refer to **FASTENER NOTICE** .

6. Install the camshaft intermediate sprocket retaining bolt (3).

Tighten: Tighten the camshaft intermediate sprocket retaining bolt to 60 N.m (44 lb ft).

IMPORTANT: DO NOT remove the pin holding the tensioner until the secondary timing chains are installed.

7. Install the primary drive chain tensioner. Refer to **Primary Camshaft Drive Chain Tensioner Replacement**.
8. Install the secondary camshaft drive chains. Refer to **Secondary Camshaft Drive Chain Replacement - Left Side** and **Secondary Camshaft Drive Chain Replacement - Right Side**.
9. Remove the pin from the primary timing chain tensioner release lever.

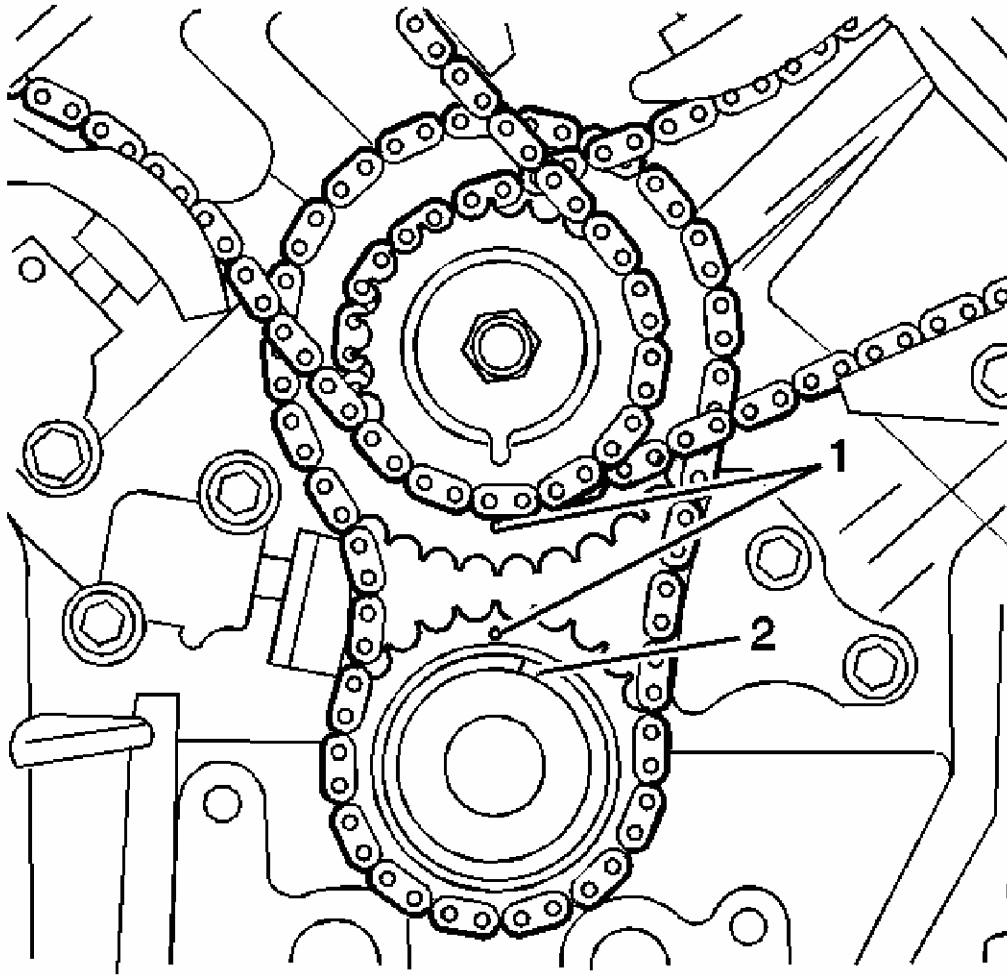


Fig. 249: Identifying Primary Timing Gear Alignment Marks
Courtesy of GENERAL MOTORS CORP.

10. Ensure the primary timing marks (1) are aligned vertically.
11. Install the oil pump. Refer to **Oil Pump Replacement**.

CAMSHAFT INTERMEDIATE DRIVE SHAFT REPLACEMENT

REMOVAL PROCEDURE

1. Remove the camshaft intermediate drive shaft sprocket. Refer to **Primary Camshaft Drive Chain and Sprockets Replacement**.

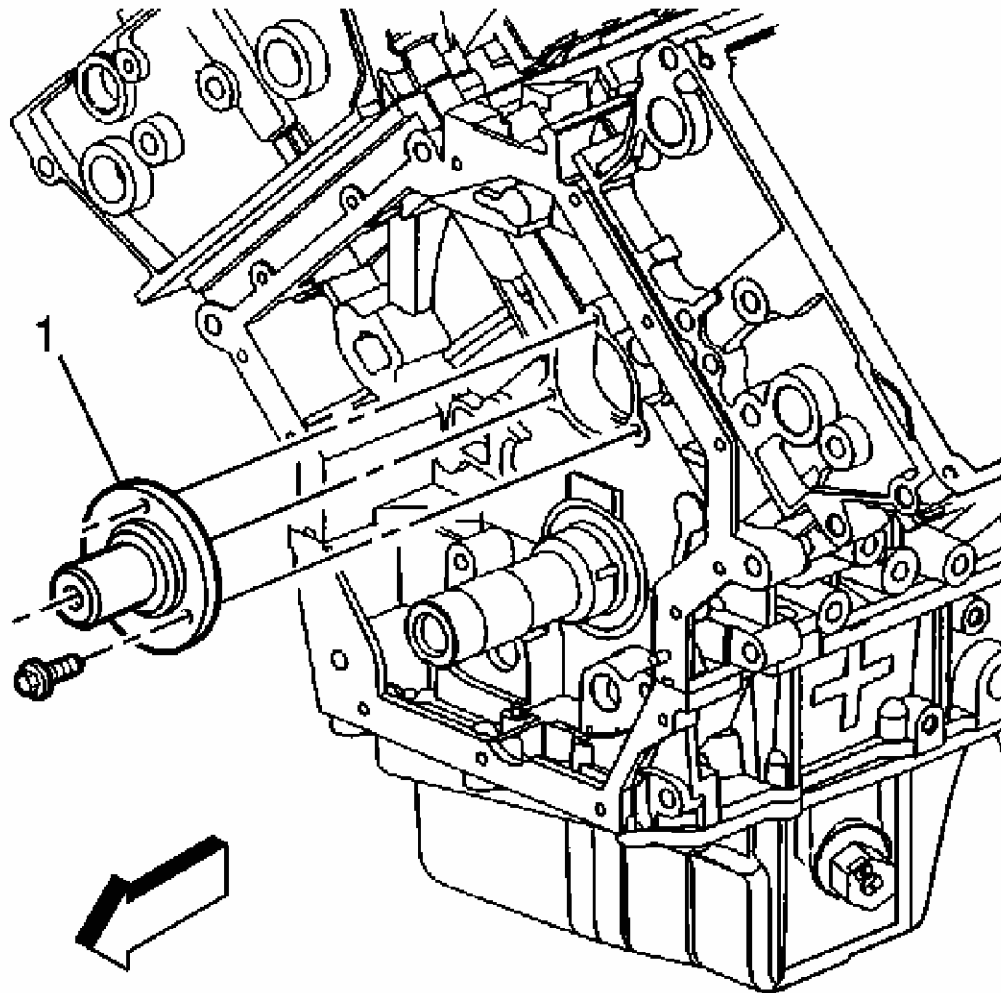


Fig. 250: Identifying Camshaft Intermediate Driveshaft
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The camshaft intermediate drive shaft should not be removed unless wear is evident.

2. Remove the camshaft intermediate drive shaft retaining bolts.
3. Remove the camshaft intermediate drive shaft (1) from the engine.
4. Clean and inspect the camshaft intermediate driveshaft. Refer to **Camshaft Intermediate Drive Shaft Cleaning and Inspection** .

INSTALLATION PROCEDURE

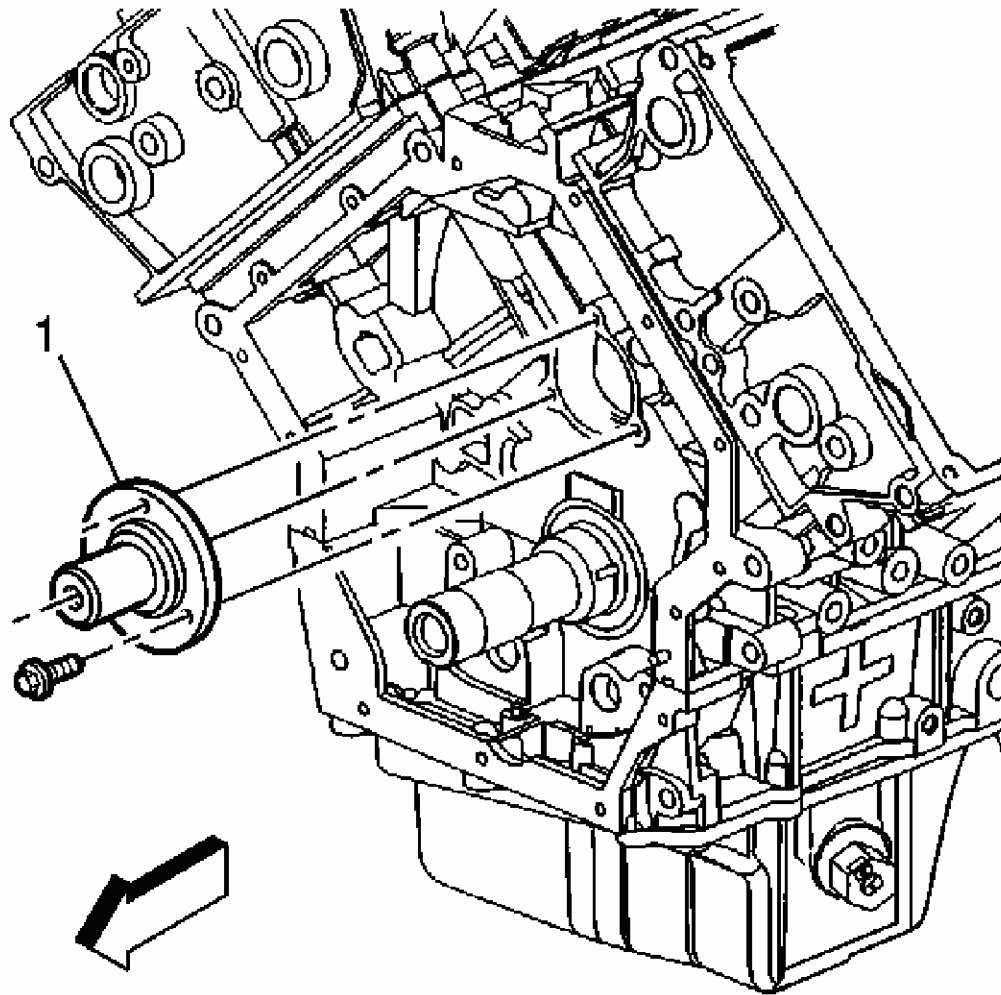


Fig. 251: Identifying Camshaft Intermediate Driveshaft
Courtesy of GENERAL MOTORS CORP.

1. Position the camshaft intermediate drive shaft (1) to the engine, aligning the bolt holes.

NOTE: Refer to Fastener Notice .

2. Install the camshaft intermediate drive shaft retaining bolts.

Tighten: Tighten the camshaft intermediate drive shaft retaining bolts to 15 N.m (11 lb ft).

3. Install the camshaft intermediate drive shaft sprocket. Refer to Primary Camshaft Drive Chain and Sprockets Replacement.

SETTING CAMSHAFT TIMING

TOOLS REQUIRED

- **J 39946** Crankshaft Rotation Socket. See **Special Tools** .
- **J 44214** Flywheel Holder. See **Special Tools** .

Setting the camshaft timing is necessary whenever the camshaft drive system has been disturbed such that the relationship between any chain and sprocket has been lost. Even when only one sprocket is involved the following procedure should be observed since one crankshaft rotation will not provide conditions where correct timing can be confirmed.

The camshafts and crankshaft events are correctly timed when the relationships shown exist. The following procedure explains how to establish this condition. Correct timing exists when the crank sprocket and the intermediate shaft sprocket have their timing marks aligned and all four camshaft drive pins are perpendicular (90 degrees) to the cylinder head surface.

TIMING PROCEDURE

1. Remove the following components for access:
 - The left camshaft cover. Refer to **Camshaft Cover Replacement - Left Side** .
 - The right camshaft cover. Refer to **Camshaft Cover Replacement - Right Side** .
 - The engine front cover. Refer to **Engine Front Cover Replacement** .
 - The three chain tensioners. Refer to **Secondary Camshaft Drive Chain Tensioner Replacement - Left Side** , **Secondary Camshaft Drive Chain Tensioner Replacement - Right Side** , **Primary Camshaft Drive Chain Tensioner Replacement** (the tensioners may be in their installed positions but must be fully retracted).
 - The oil pump. Refer to **Oil Pump Replacement** .

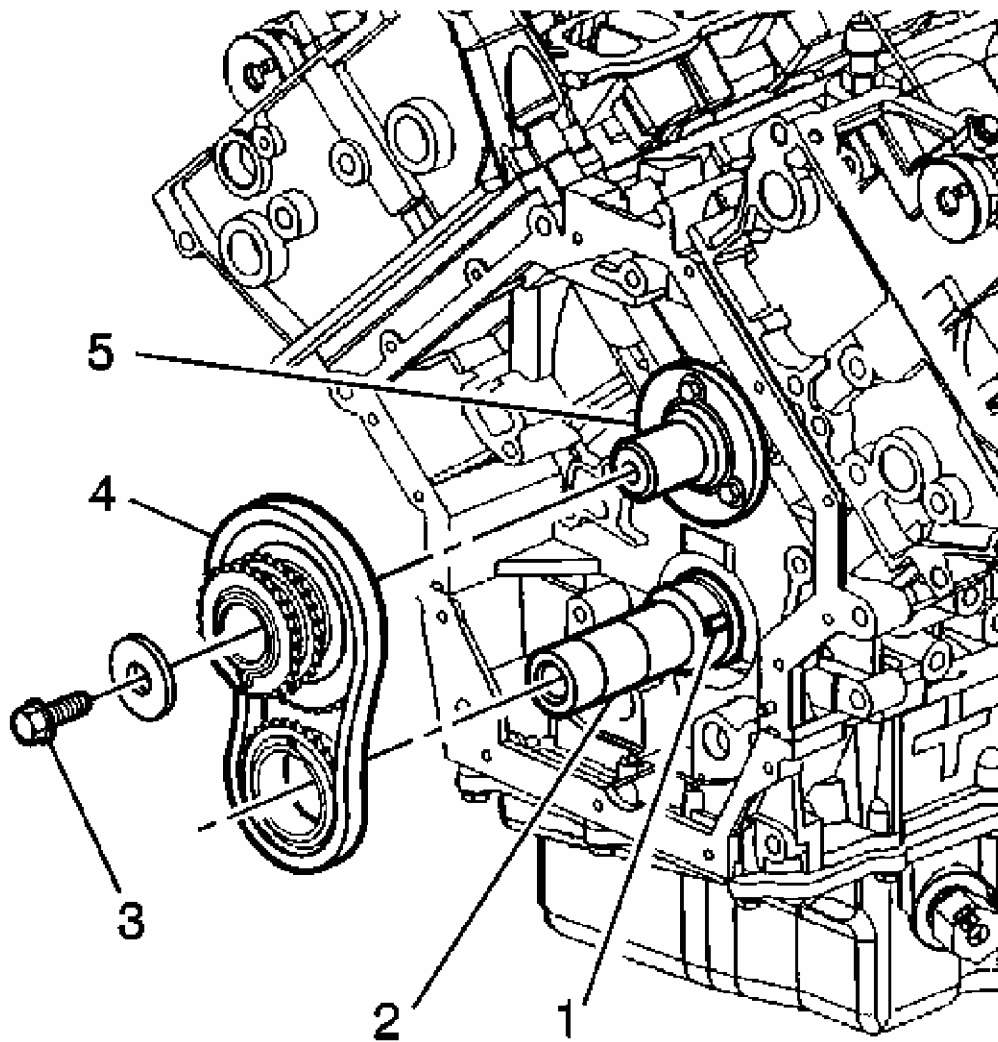


Fig. 252: Identifying Camshaft Intermediate Sprocket Retaining Bolt & Camshaft Drive Chain

Courtesy of GENERAL MOTORS CORP.

2. The primary and secondary chain guides should be reinstalled if previously removed.
3. Rotate the crankshaft (2) until the sprocket drive key (1) is at approximately the 1 o'clock position. Use the **J 39946** to rotate the crankshaft (2). See **Special Tools**.
4. Install the crankshaft and the intermediate shaft sprockets to the primary drive chain with their timing marks adjacent to each other.
5. Install the crank and intermediate sprocket assembly (4) over their respective shafts.
6. Rotate the crankshaft (2) as necessary to engage the crankshaft key (1) in the sprocket

without changing the relationship of the timing marks to each other. Use the **J 39946** to rotate the crankshaft (2). See **Special Tools**.

NOTE: Refer to **Fastener Notice**.

7. Install the camshaft intermediate sprocket bolt (3).

Tighten: Tighten the camshaft intermediate sprocket bolt to 60 N.m (44 lb ft).

8. Install the primary camshaft drive chain tensioner or release the tensioner shoe.

Tighten: Tighten the primary camshaft drive chain tensioner bolts to 25 N.m (18 lb ft).

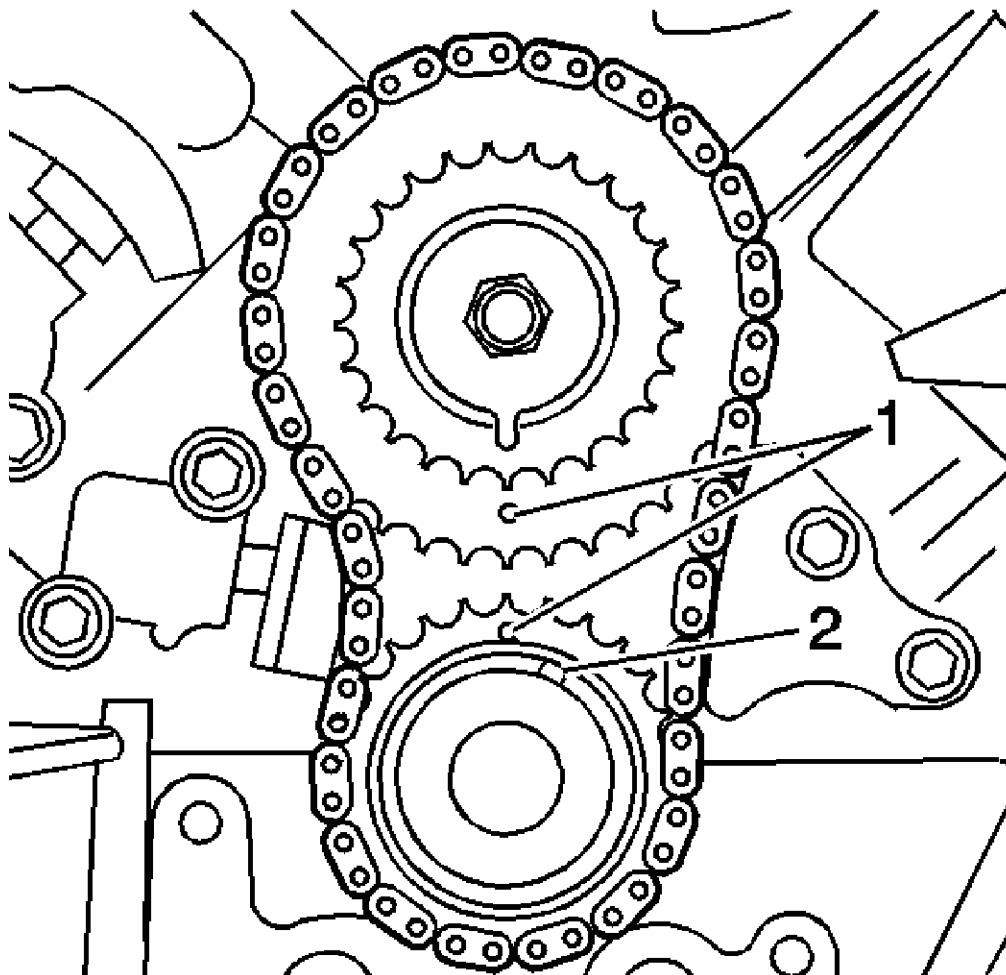


Fig. 253: Ensuring Vertical Timing Mark Alignment

Courtesy of **GENERAL MOTORS CORP.**

9. Ensure the timing marks (1) are aligned vertically.
10. Install the **J 44214** to lock the crankshaft in this position. See **Special Tools** . If the engine is on a stand, an alternate method should be devised.

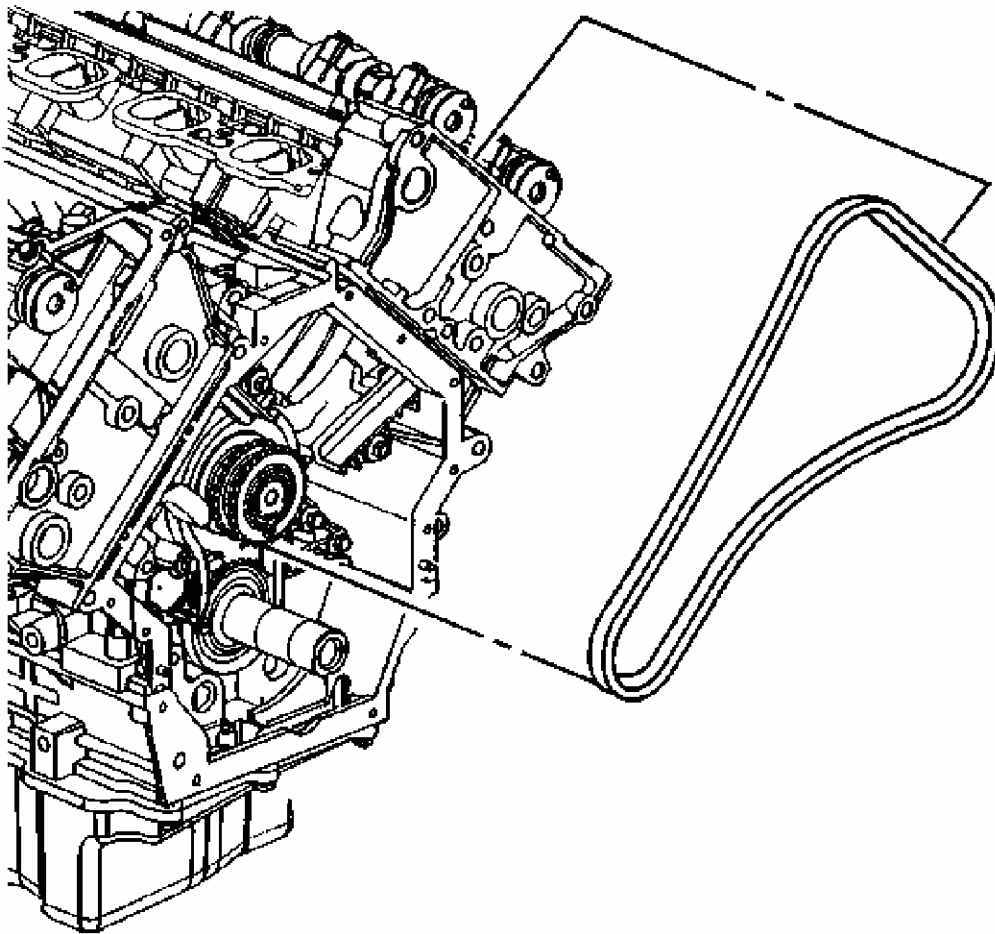


Fig. 254: View of Secondary Drive Chain
Courtesy of **GENERAL MOTORS CORP.**

11. Route the secondary drive chain for the LH cylinder head over the inner row of intermediate shaft teeth.

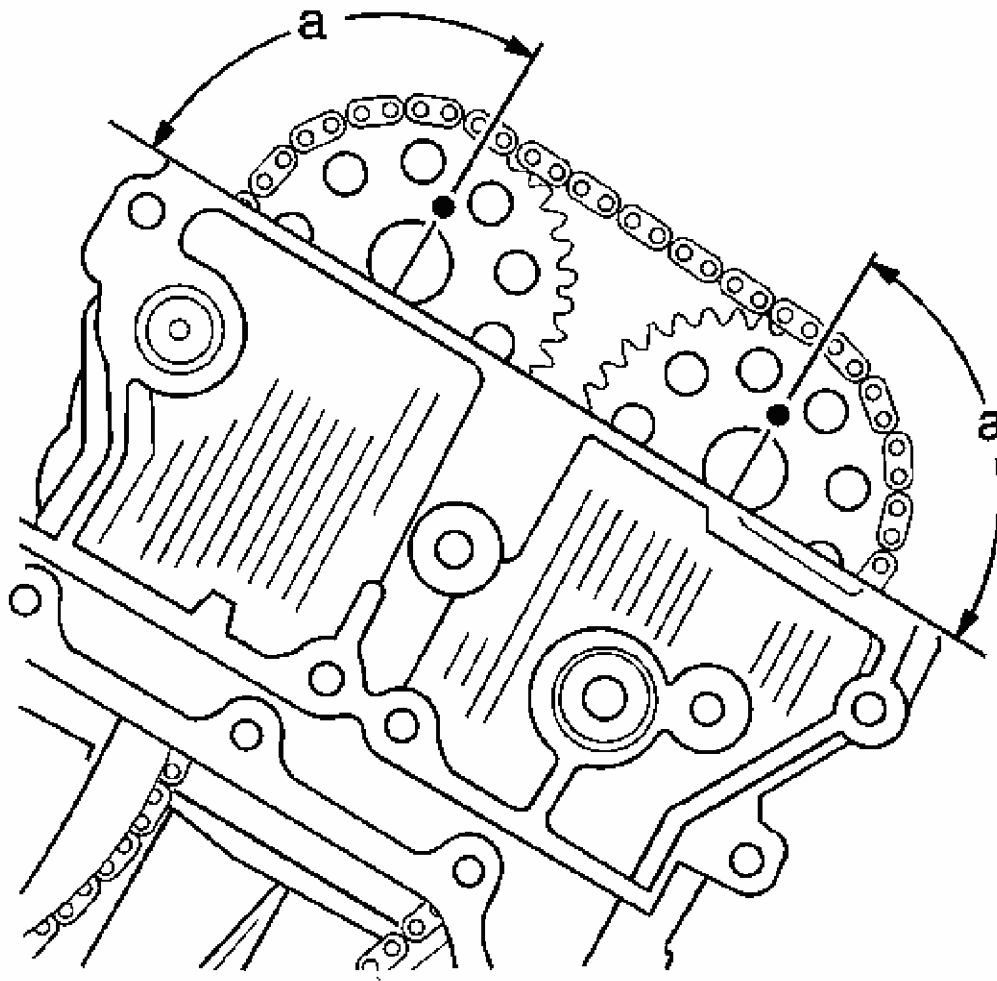


Fig. 255: Routing Secondary Drive Chain
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The RE camshaft sprocket must contain the camshaft position sensor pick-up.

12. Route the secondary drive chain over the chain guide and install the exhaust camshaft sprocket to the chain such that the camshaft drive pin engages the sprocket notch marked LE (left head exhaust). There should be no slack in the lower section of the chain and the camshaft drive pin must be perpendicular to the cylinder head face.
13. Install the intake camshaft sprocket into the chain so that the sprocket notch marked LI (left head intake) engages the camshaft drive pin while the pin remains perpendicular to the cylinder head face. A hex is cast into the camshafts behind the lobes for cylinder -1

(or -2, LH) so that an open end wrench may be used to provide minor repositioning of the camshafts.

14. Loosely install the exhaust camshaft sprocket retainer bolt.
15. Loosely install the intake camshaft sprocket retainer bolt.

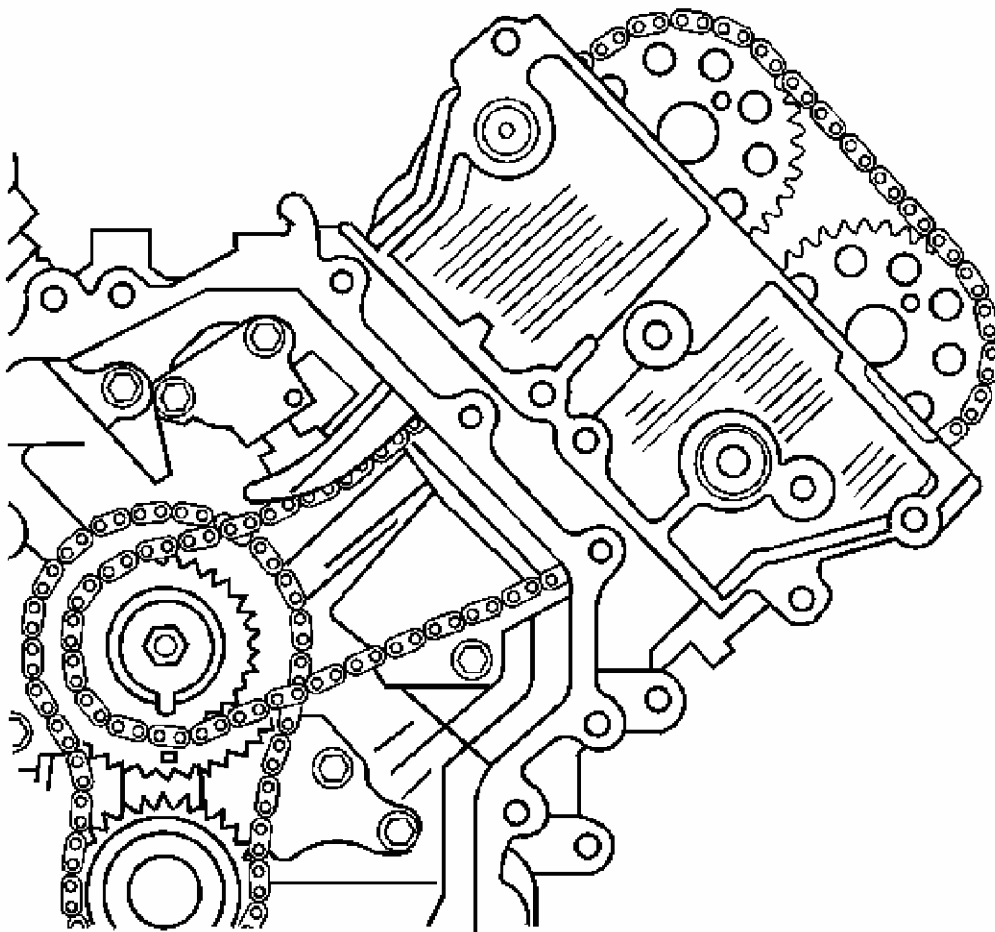


Fig. 256: View Of Secondary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

16. Install the secondary camshaft drive chain tensioner or release the tension on the shoe.

Tighten:

- Tighten the secondary camshaft drive chain tensioner bolts to 25 N.m (18 lb ft).
- Tighten the camshaft sprocket bolts to 120 N.m (89 lb ft).

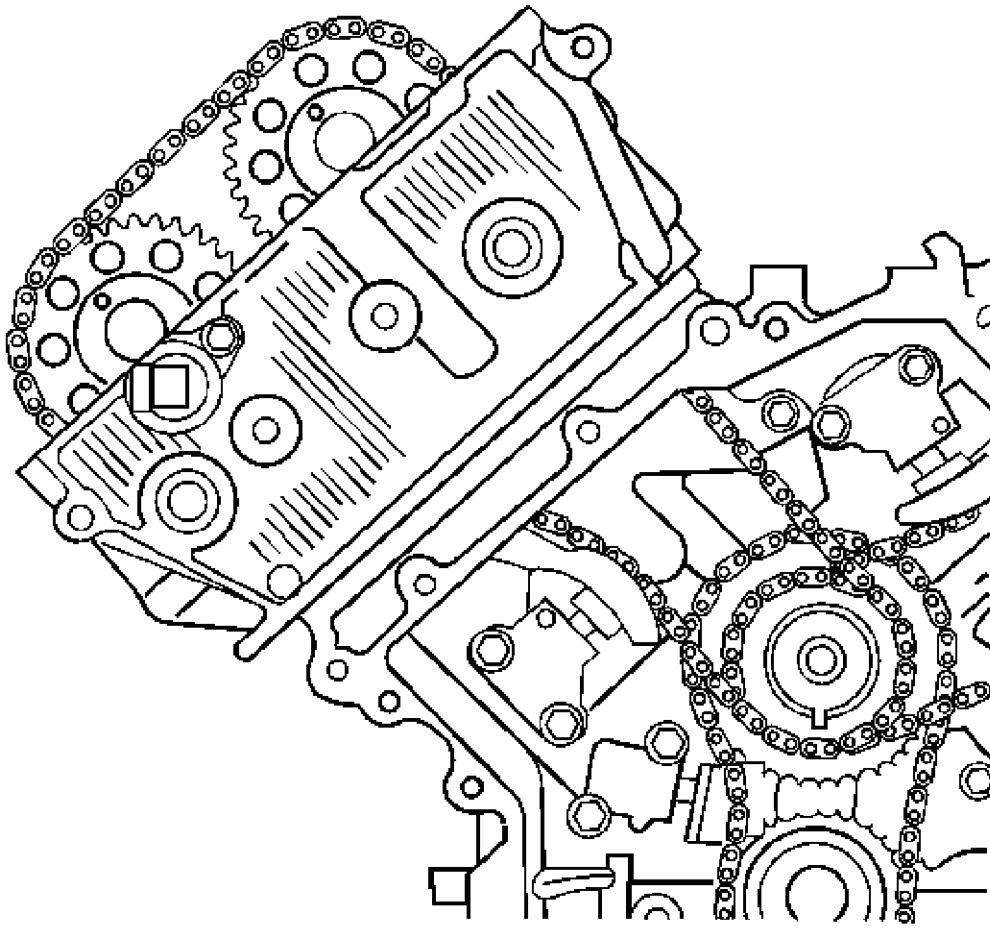


Fig. 257: Routing Secondary Drive Chain For Right Side Cylinder Head
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The RE camshaft sprocket must contain the camshaft position sensor pick-up.

17. Route the secondary drive chain for the right side cylinder head over the outer row of the intermediate shaft teeth and repeat steps 11 through 15 for right side camshafts. Right side camshaft sprockets are identified as RI (right intake) and RE (right exhaust). In addition the RE sprocket must contain the camshaft position sensor pickup.

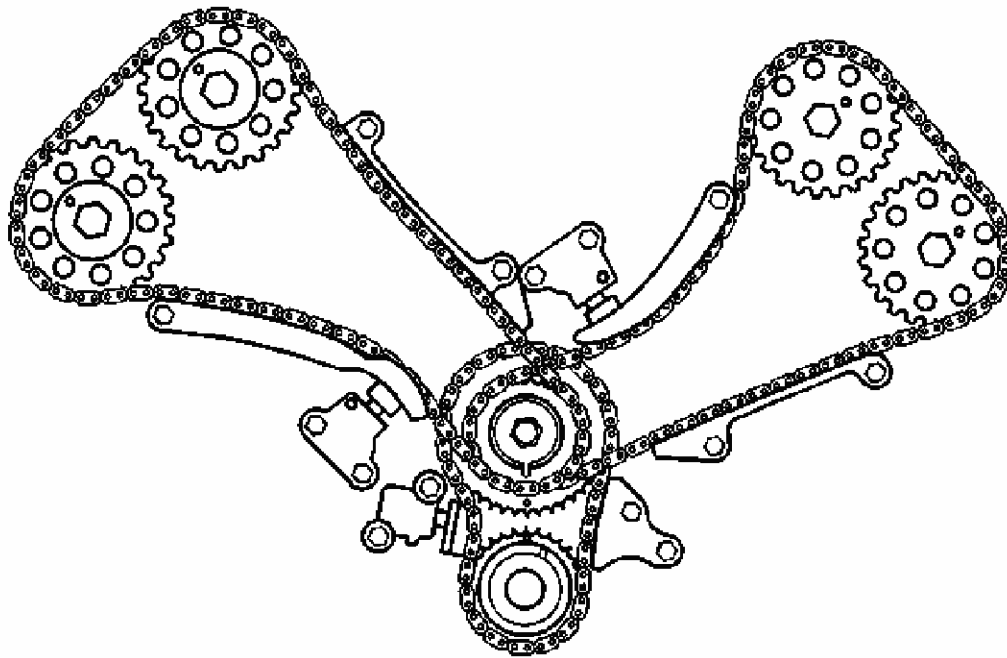


Fig. 258: Identifying Proper Alignment Of Timing Marks
Courtesy of GENERAL MOTORS CORP.

18. Ensure all timing marks are properly aligned.
19. Install the following components:
 - The oil pump. Refer to **Oil Pump Replacement** .
 - The engine front cover. Refer to **Engine Front Cover Replacement** .
 - The right camshaft cover. Refer to **Camshaft Cover Replacement - Right Side** .
 - The left camshaft cover. Refer to **Camshaft Cover Replacement - Left Side** .

CAMSHAFT REPLACEMENT - LEFT SIDE

TOOLS REQUIRED

- **EN 46327** Timing Chain Retention Tool. See **Special Tools** .
- **J 45059** Angle Meter
- **J 44212** Camshaft Holding Tool. See **Special Tools** .

REMOVAL PROCEDURE

1. Remove the left camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.

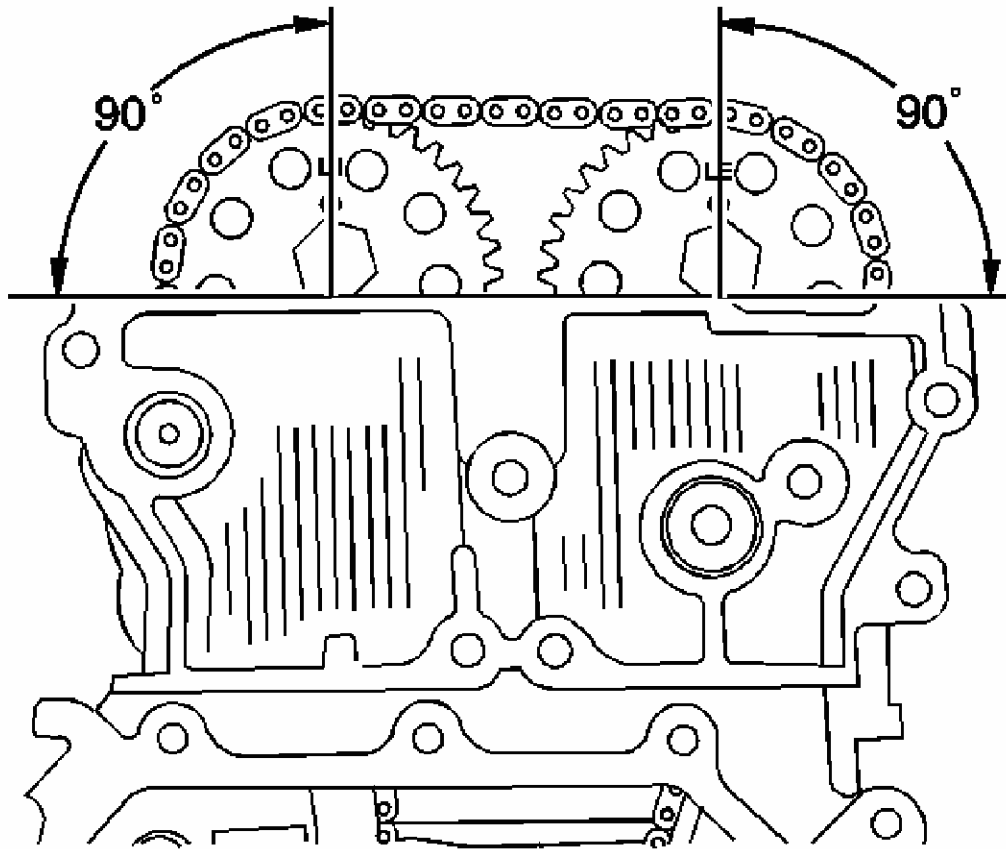


Fig. 259: Ensuring Camshaft Sprocket Drive Pins Are At The Top Of Their Rotation

Courtesy of GENERAL MOTORS CORP.

2. Rotate the crankshaft to TDC of the # 1 cylinders compression stroke, both camshaft sprocket drive pins should be at the top of their rotation.

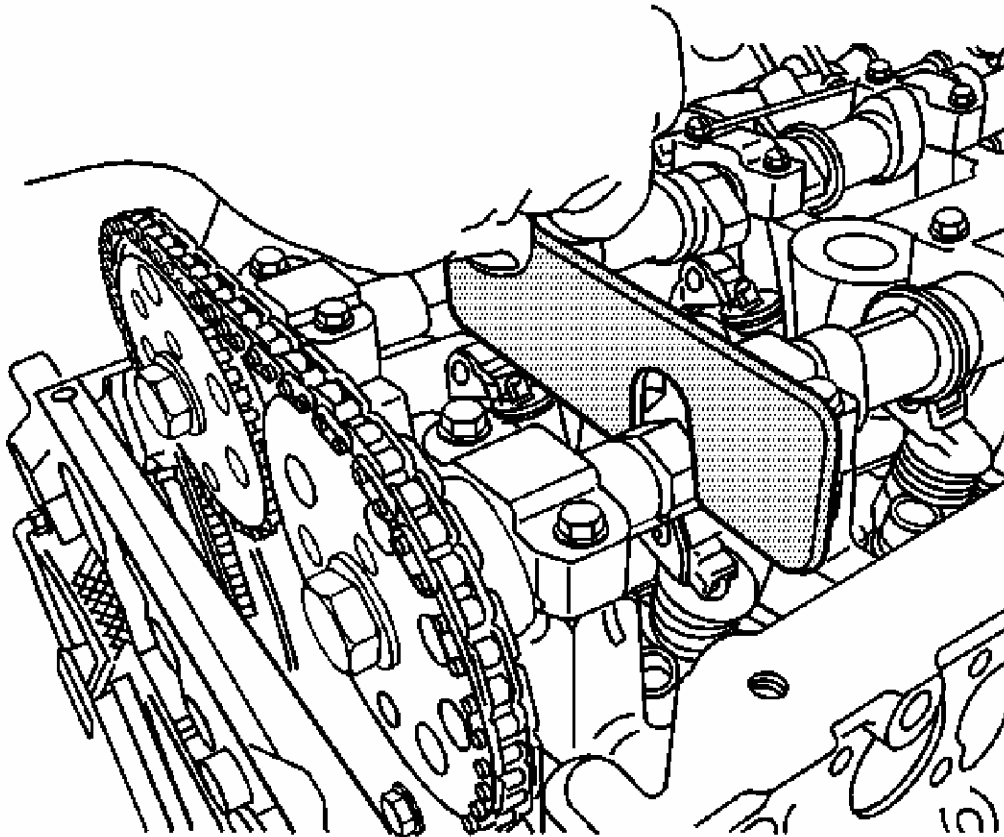


Fig. 260: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Camshaft Holding Tool Caution .

3. Install the **J 44212** over the camshafts. See Special Tools .

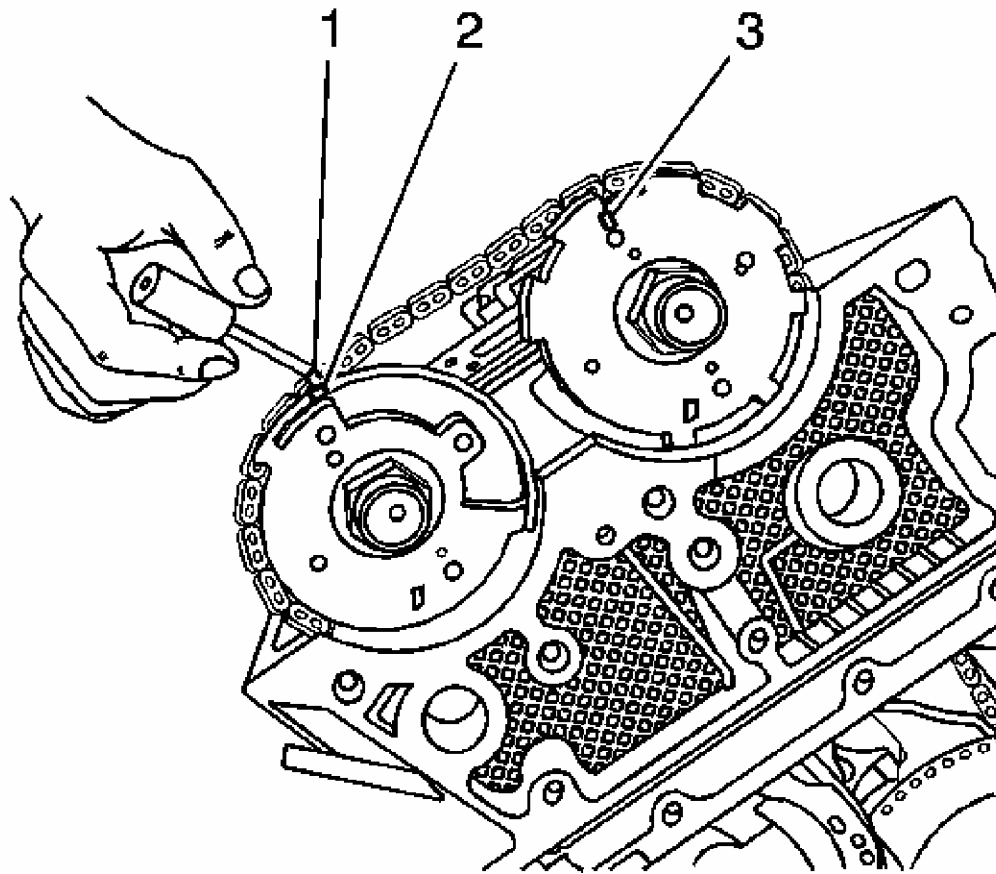


Fig. 261: Using A Paint Stick To Create A Mark On The Timing Chain Link Adjacent To Each Camshaft Sprocket Timing Mark
Courtesy of GENERAL MOTORS CORP.

4. Use a paint stick to create a mark (1) on the timing chain link adjacent to each camshaft sprocket timing mark (2, 3).

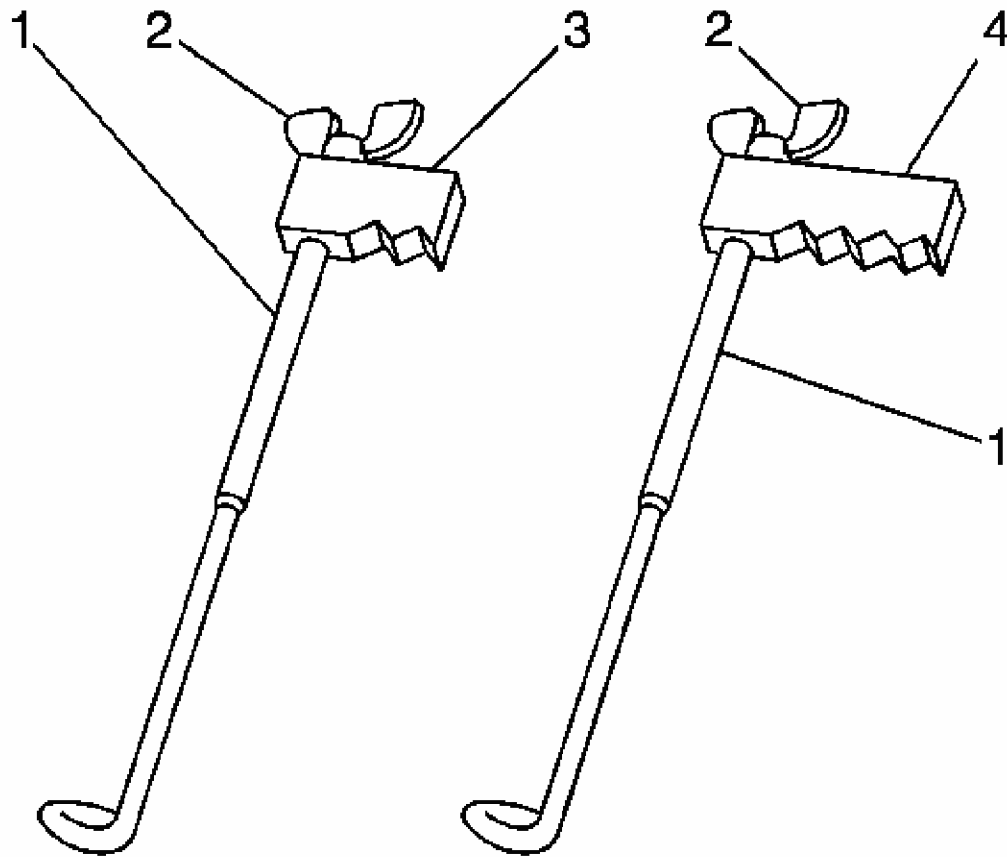


Fig. 262: Identifying Timing Chain Retention Tool Components
Courtesy of GENERAL MOTORS CORP.

5. Install both **EN 46327** (1) to the engine using the following step: See **Special Tools** .
Rotate the wing nut (2) of the **EN 46327** (3) to the top of its travel. See **Special Tools** .

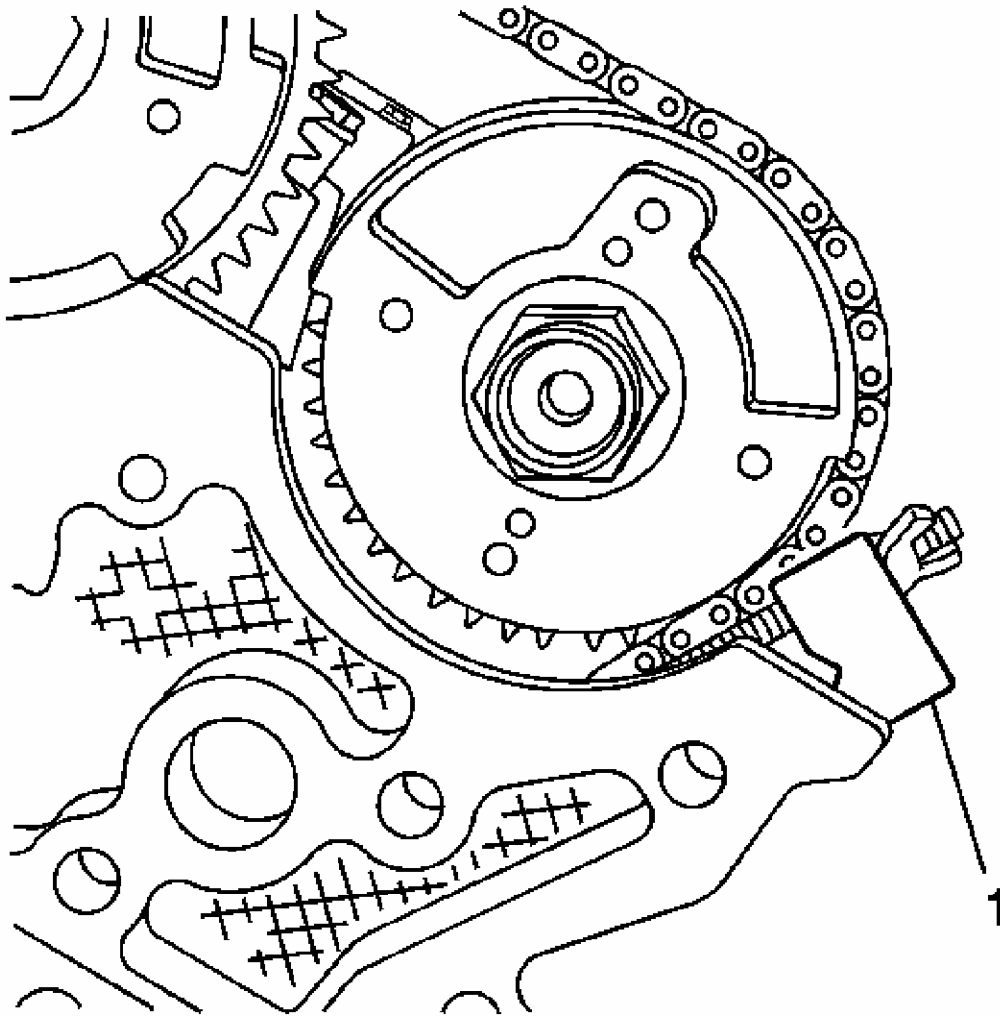


Fig. 263: Positioning EN 46327 On The Cylinder Head
Courtesy of GENERAL MOTORS CORP.

6. Position the bottom retention tool on the cylinder head with the V-notch of the block (1) adjacent to the left exhaust camshaft sprocket and chain.

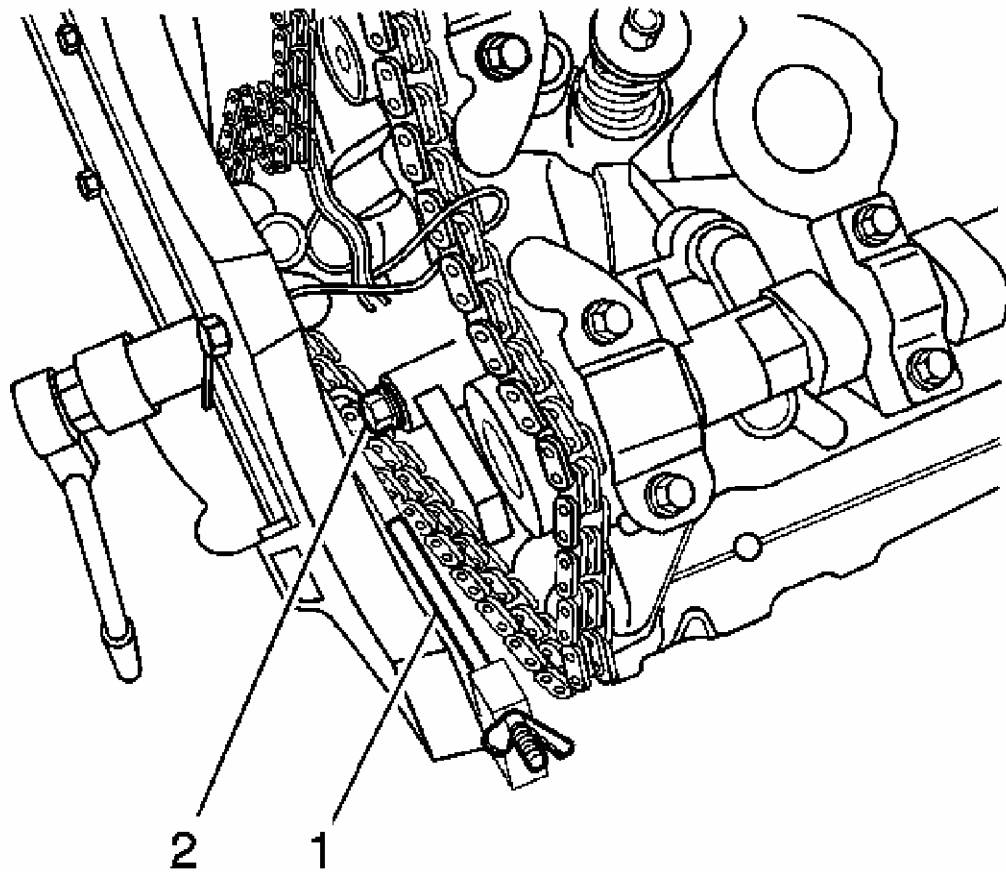


Fig. 264: Installing EN 46327 Hook End Into Secondary Timing Chain Link
Courtesy of GENERAL MOTORS CORP.

7. Insert the hook end (2) into a secondary timing chain link as shown.

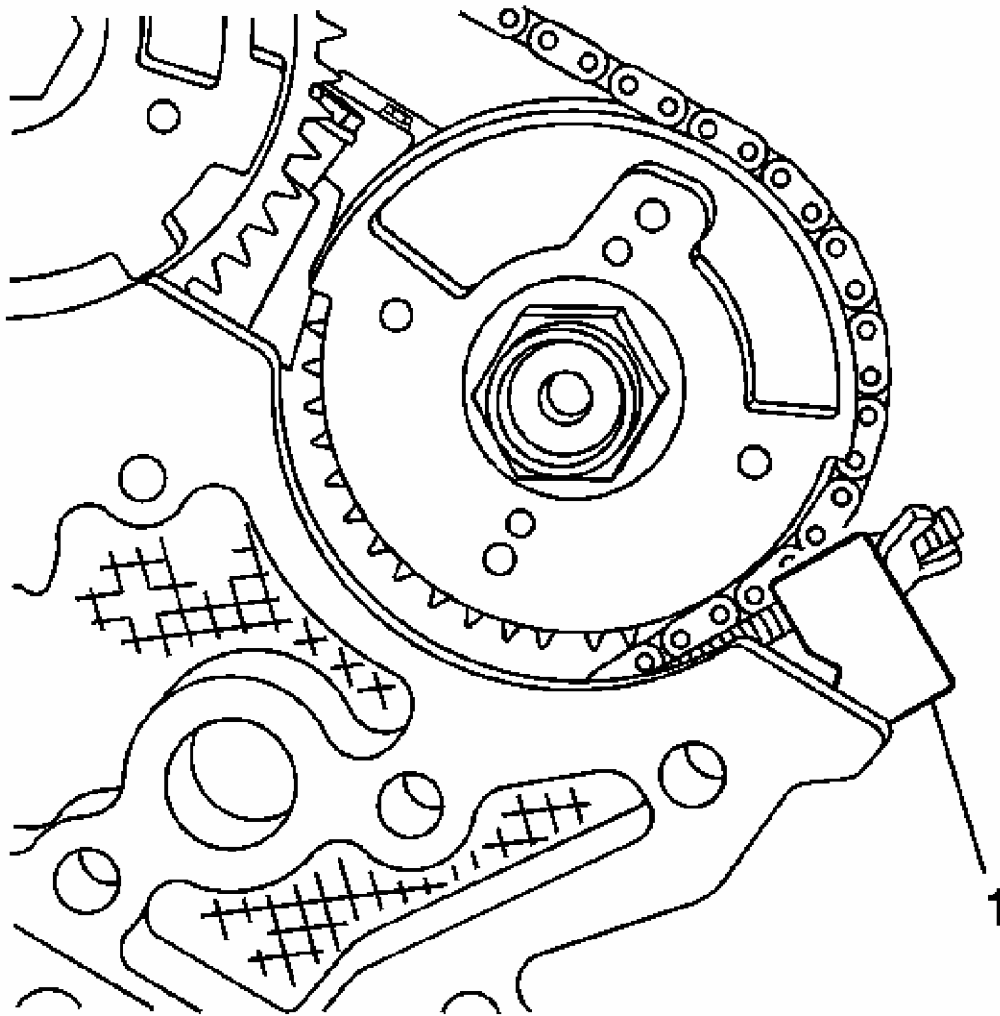


Fig. 265: Positioning EN 46327 On The Cylinder Head
Courtesy of GENERAL MOTORS CORP.

8. Rotate the wing nut until it contacts the retention tool block (1). DO NOT tighten the wing nut at this time.

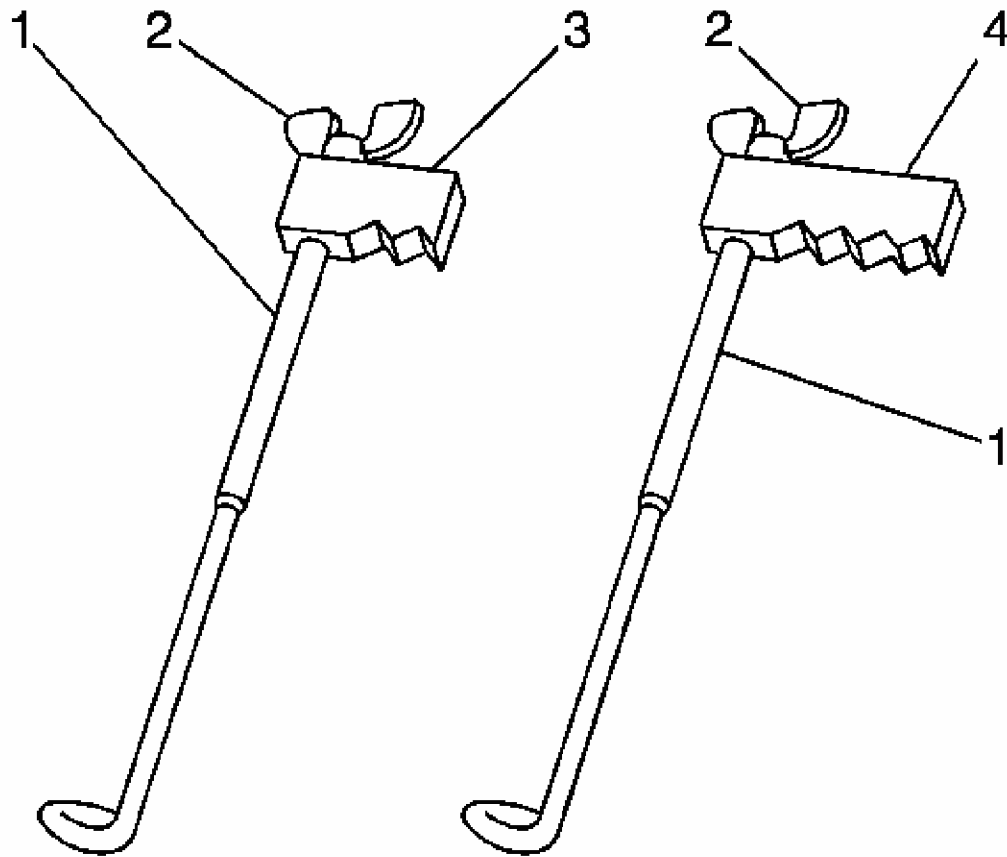


Fig. 266: Identifying Timing Chain Retention Tool Components
Courtesy of GENERAL MOTORS CORP.

9. Rotate the wing nut (2) of the **EN 46327** (4) to the top of its travel. See **Special Tools** .

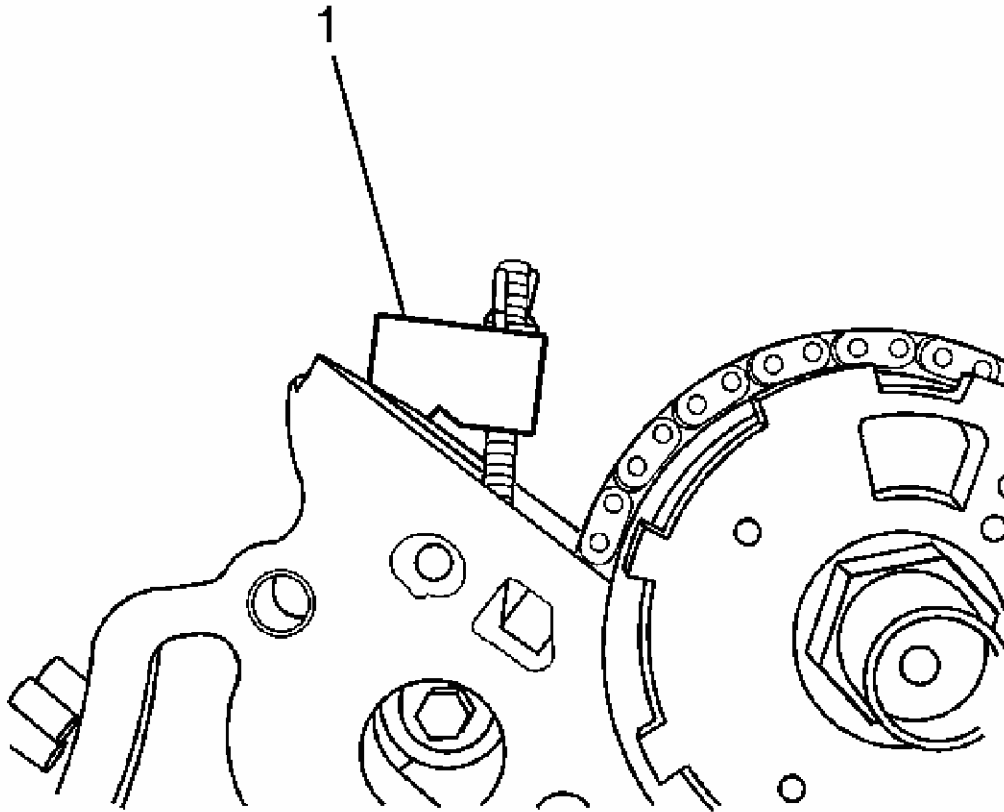


Fig. 267: Positioning Top Retention Tool On Cylinder Head
Courtesy of GENERAL MOTORS CORP.

10. Position the top retention tool on the cylinder head with the V-notch of the block (1) adjacent to the left intake camshaft sprocket and chain.

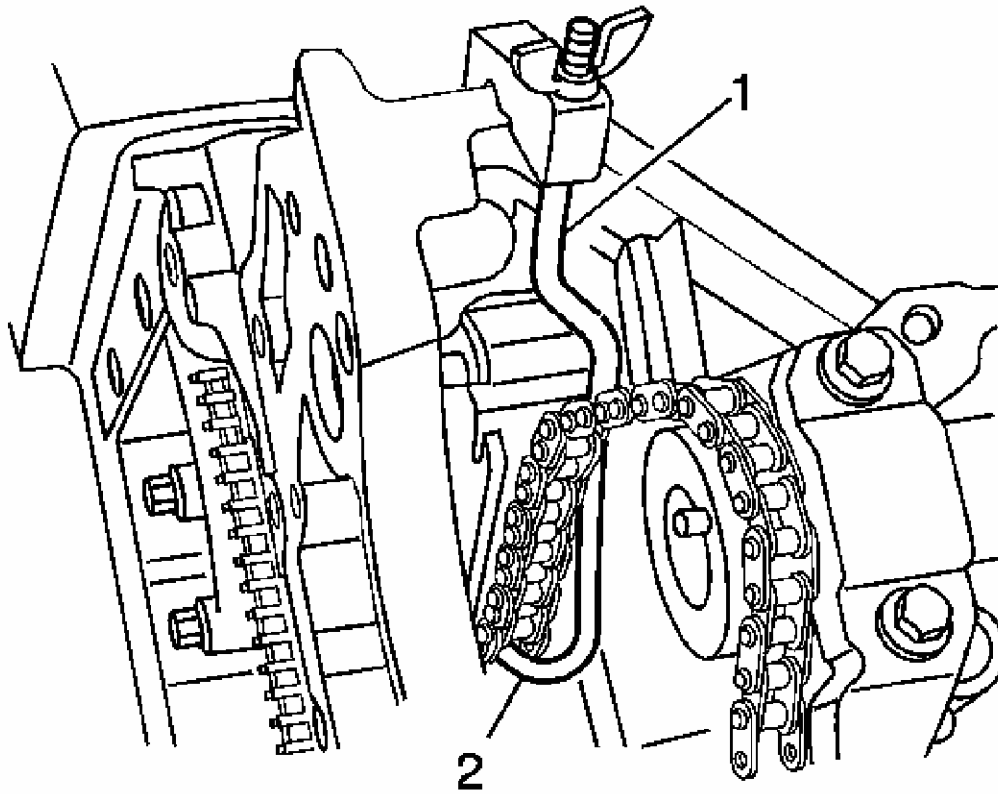


Fig. 268: View Of Hook End In Secondary Timing Chain Link
Courtesy of GENERAL MOTORS CORP.

11. Insert the hook end (2) into a secondary timing chain link as shown.

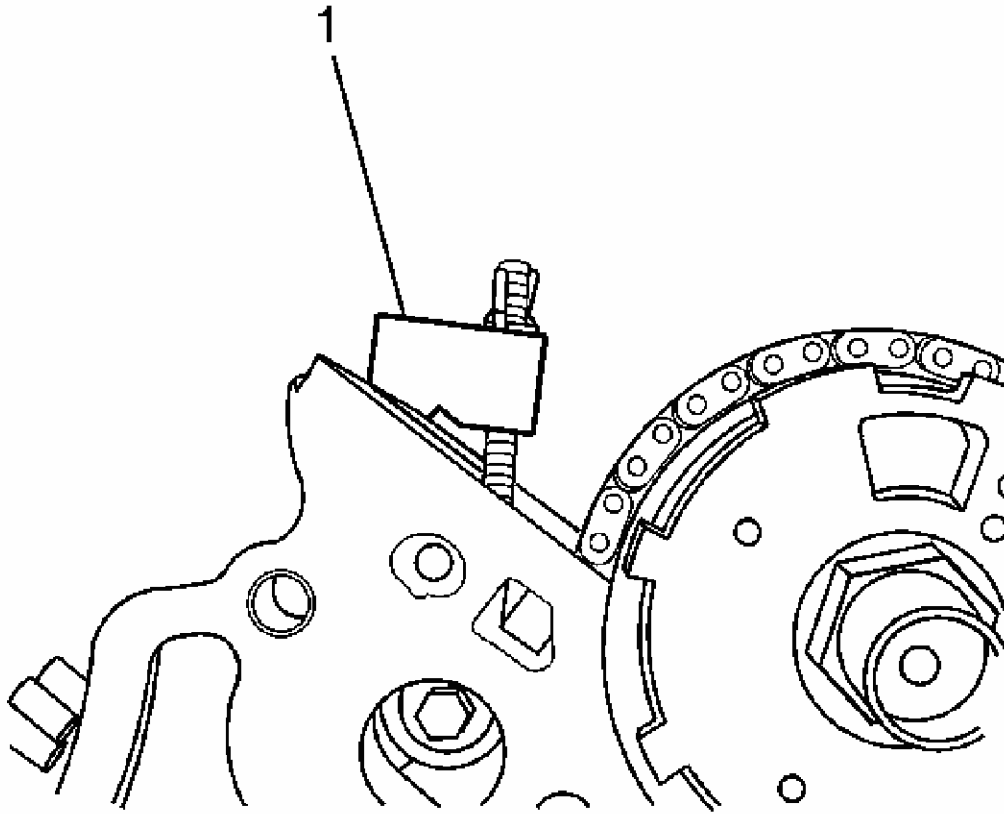


Fig. 269: Positioning Top Retention Tool On Cylinder Head
Courtesy of GENERAL MOTORS CORP.

12. Rotate the wing nut until it contacts the retention tool block (1). Alternately tighten both wing nuts to retain the chain.

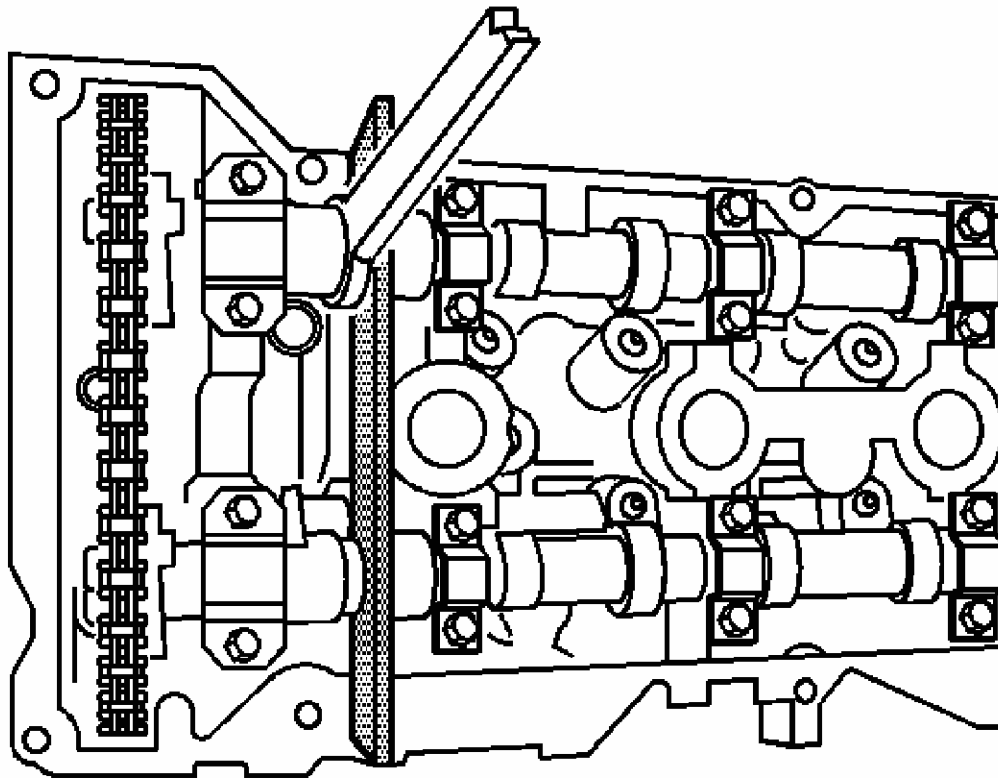


Fig. 270: Holding Camshaft
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Torque Reaction Against Timing Drive Chain Notice .

13. Use an open wrench on the hex cast into the camshafts in order to prevent the camshafts from rotating when removing the camshaft sprocket bolts.
14. Remove the camshaft sprocket bolts.
15. Remove the camshaft sprockets.

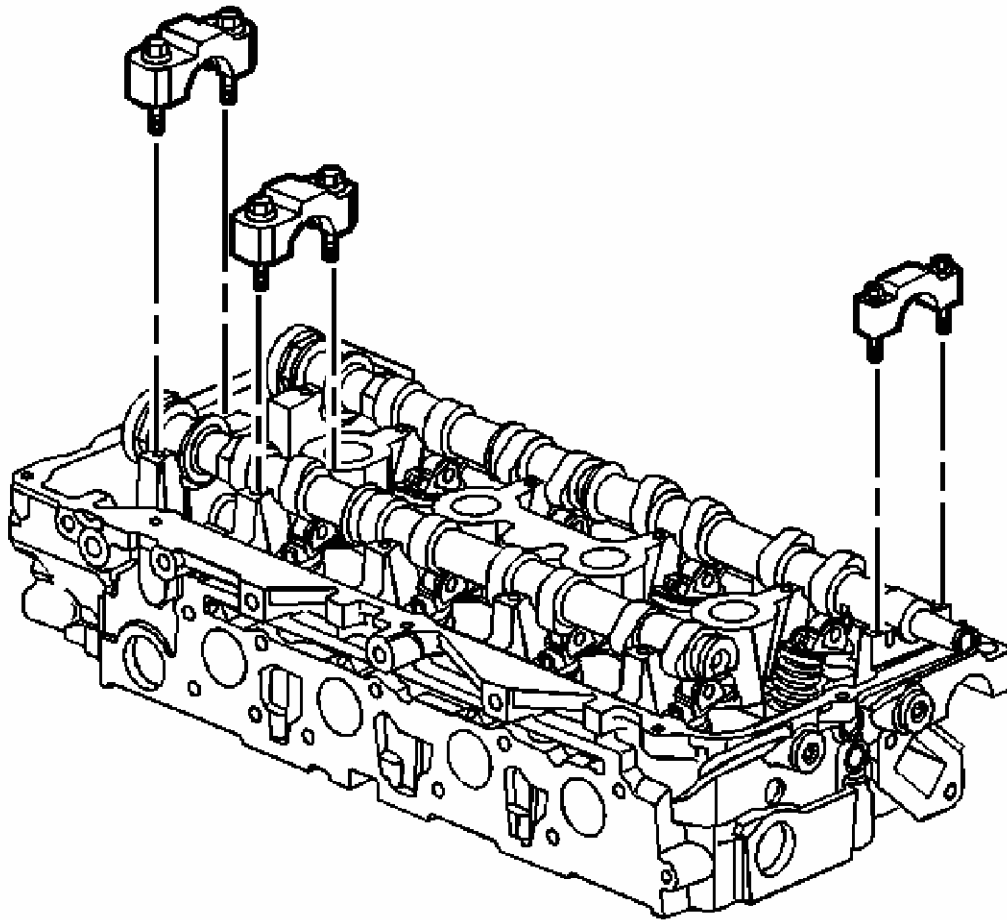


Fig. 271: View of Camshaft Bearing Caps
Courtesy of GENERAL MOTORS CORP.

16. Alternately loosen the camshaft bearing cap bolts a few turns at a time until all valve spring pressure has been released.
17. Remove the camshaft bearing caps.
18. Remove the **J 44212** from the camshafts. See **Special Tools** .

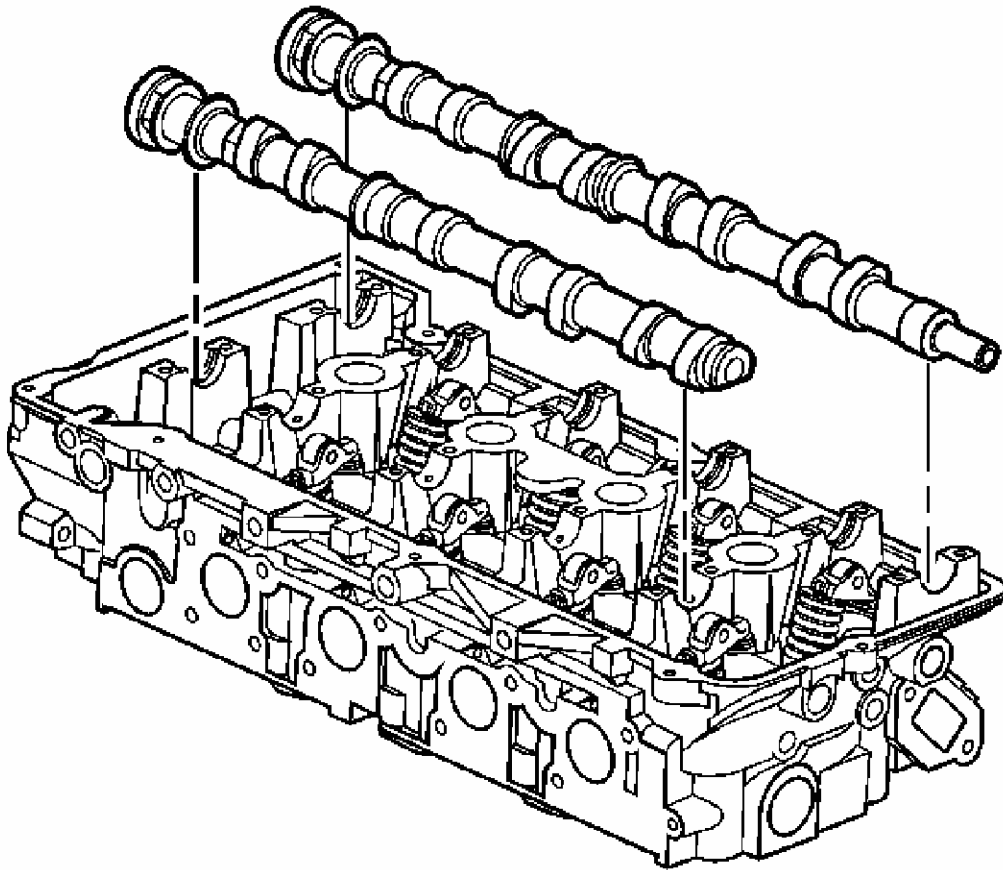


Fig. 272: View Of Camshafts
Courtesy of GENERAL MOTORS CORP.

19. Remove the camshafts.

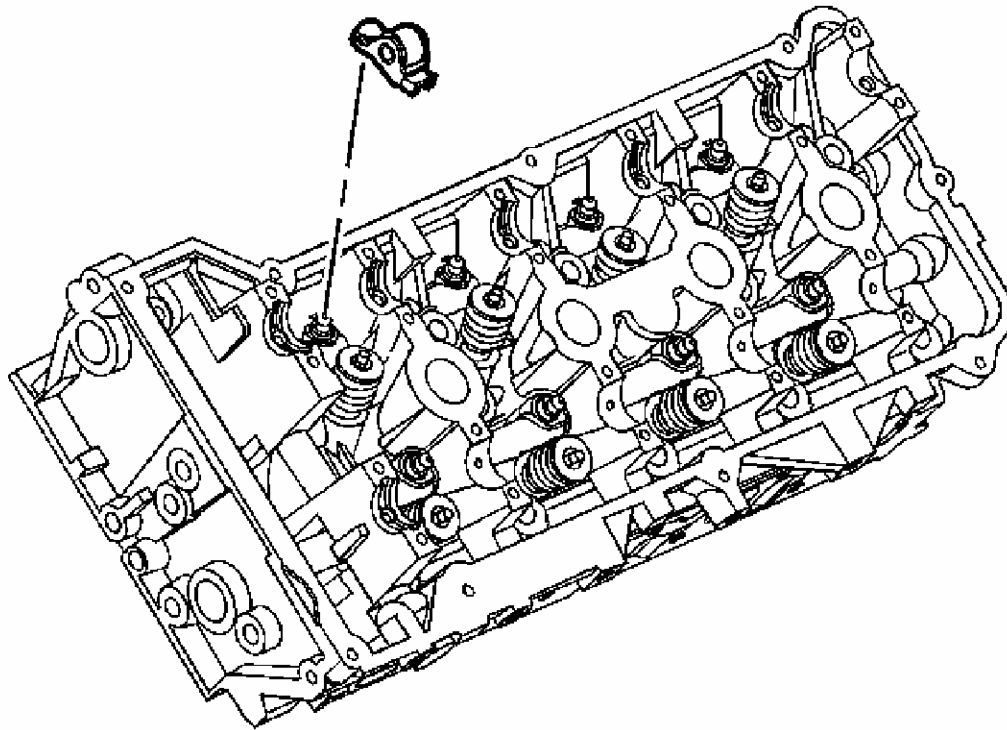


Fig. 273: Identifying Camshaft Followers
Courtesy of GENERAL MOTORS CORP.

20. Remove the camshaft followers.
21. Clean and inspect the camshafts. Refer to **Camshaft Cleaning and Inspection** .

INSTALLATION PROCEDURE

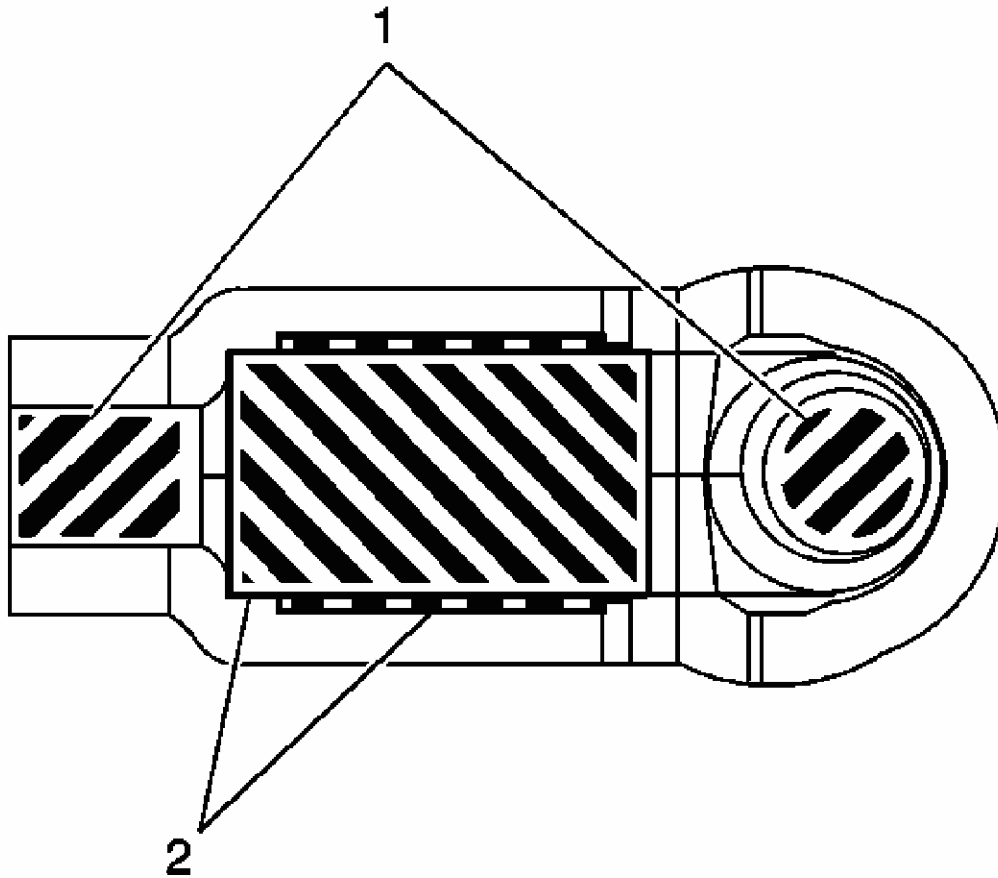


Fig. 274: Identifying Roller Pivot Pocket (2) & Valve Slot Areas (1) Of Camshaft Followers

Courtesy of GENERAL MOTORS CORP.

1. Apply a liberal amount of lubricant to the roller pivot pocket (2) and valve slot areas (1) of the camshaft followers. Refer to **Sealers, Adhesives and Lubricants** .

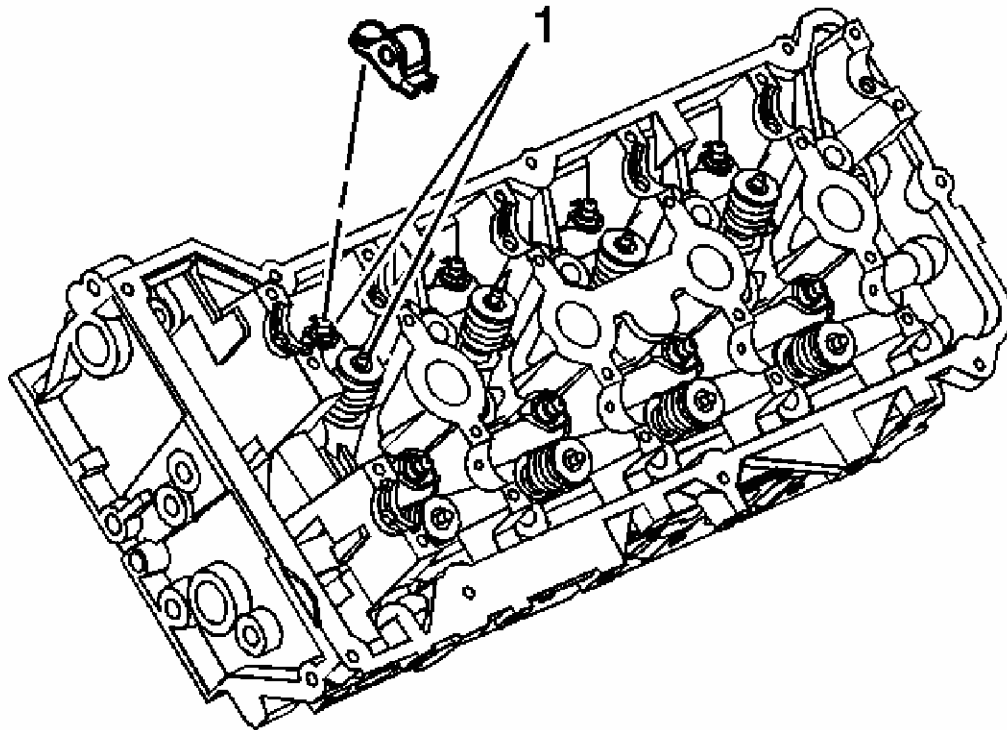


Fig. 275: Identifying Stationary Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The follower must be positioned squarely on the valve tip so that the full width of the roller will completely contact the camshaft lobe. If the followers are being reused you must put them back in their original location.

2. Place the camshaft followers in position on the valve tip and the stationary hydraulic lash adjusters (SHLA) (1). The rounded head of the follower goes on the SHLA, while the flat end goes on the valve tip.
3. Clean the camshaft carriers with a clean, lint-free cloth.

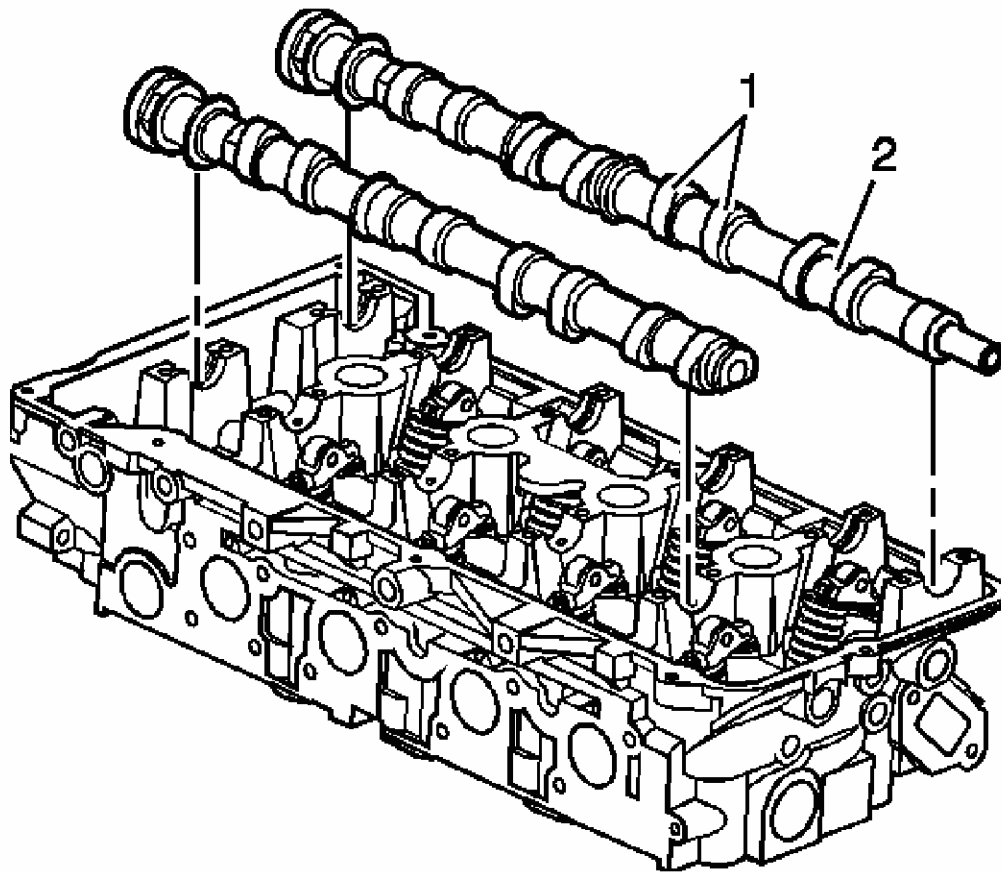


Fig. 276: Identifying Camshaft Lobes & Journals
Courtesy of GENERAL MOTORS CORP.

4. Apply a liberal amount of lubricant to the camshaft carriers, camshaft lobes (1) and the camshaft journals (2). Refer to **Sealers, Adhesives and Lubricants** .
5. Place the camshaft in the camshaft carriers with the camshaft sprocket drive pins near the top of their rotation and the camshaft lobes in a neutral position. The camshafts can be identified by a stamping near the rear journal. For example: L-EXH is defined as Left bank Exhaust.

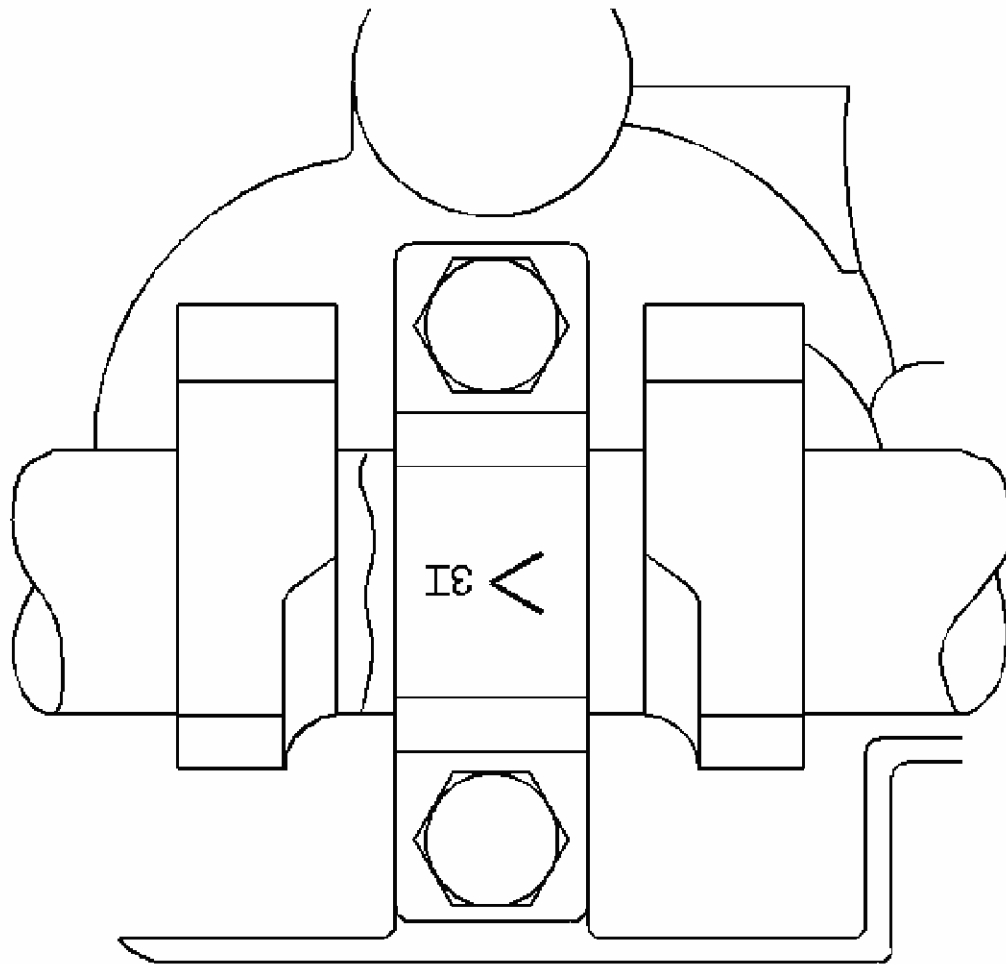


Fig. 277: Identifying Camshaft Bearing Cap Markings
Courtesy of GENERAL MOTORS CORP.

6. Observe the markings on the camshaft bearing caps. Each camshaft bearing cap is marked in order to identify its location. The markings have the following meanings:
 - The arrow should point to the front of the engine.
 - The number indicates the position from the front of the engine.
 - The "E" indicates the exhaust camshaft.
 - The "I" indicates the Intake camshaft.
7. Apply a liberal amount of lubricant to the camshaft bearing caps. Refer to **Sealers, Adhesives and Lubricants** .

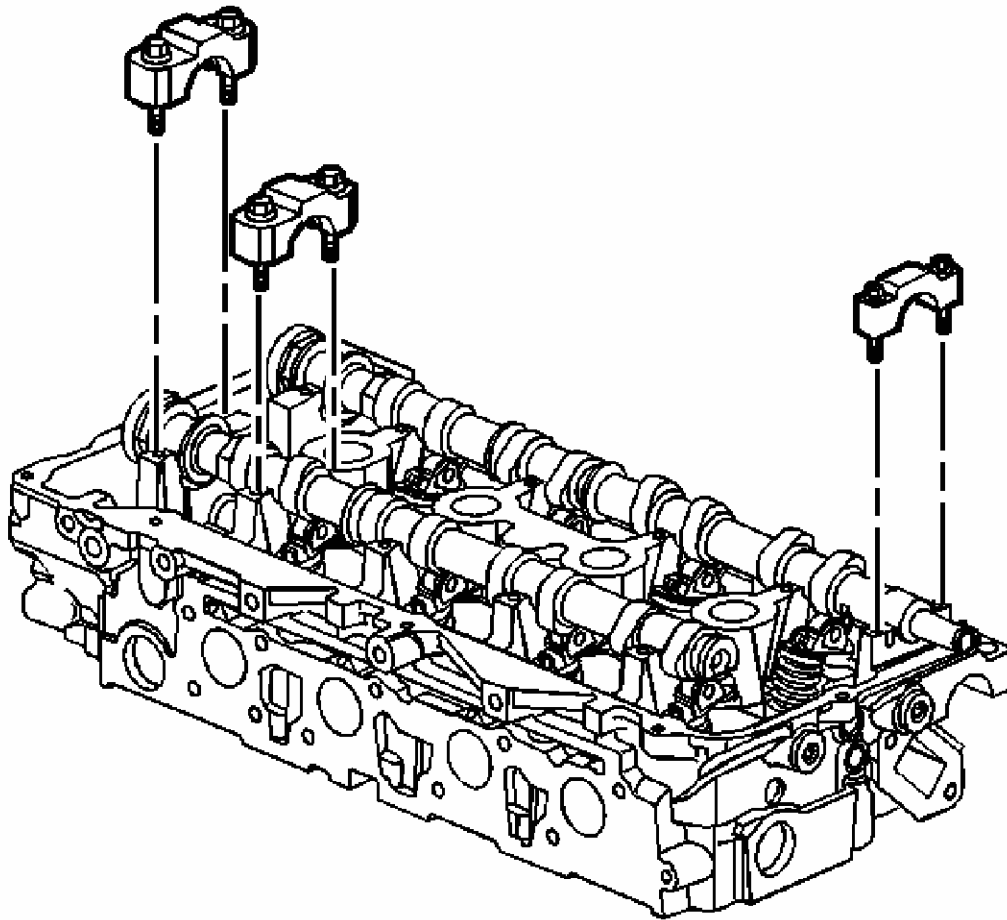


Fig. 278: View of Camshaft Bearing Caps
Courtesy of GENERAL MOTORS CORP.

8. Install the camshaft bearing caps according to the identification marks.

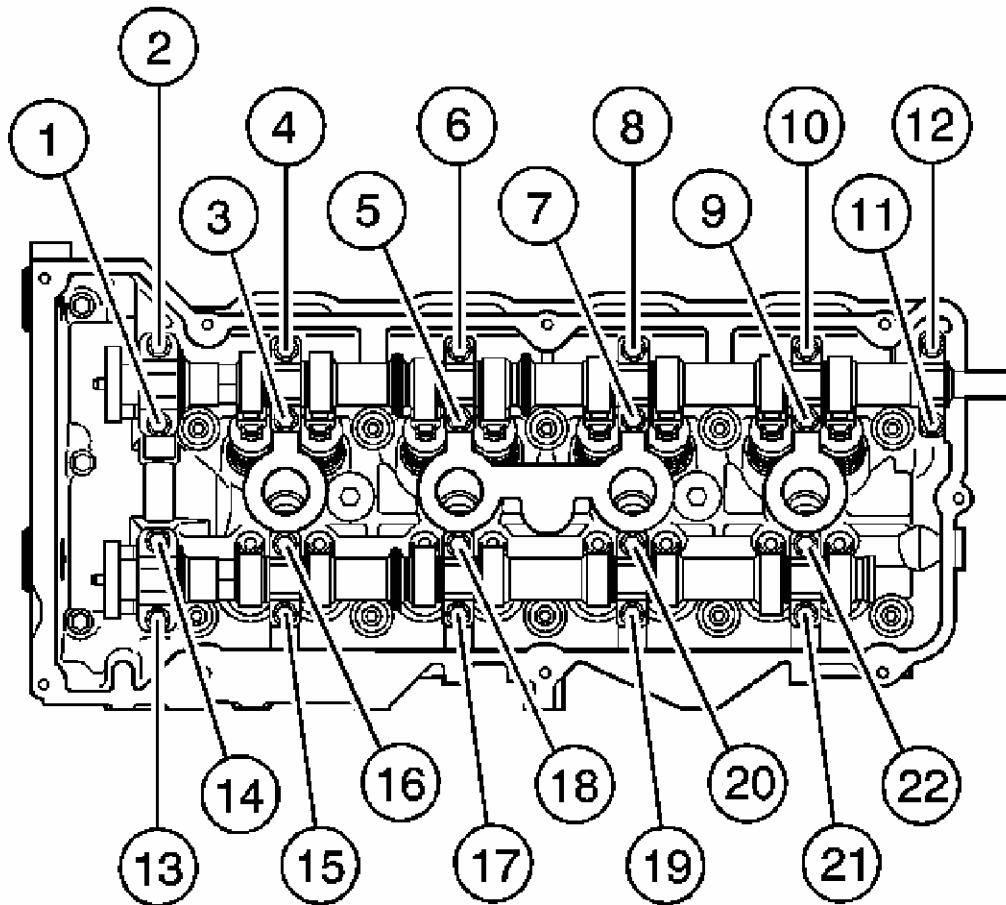


Fig. 279: Camshaft Bearing Cap Bolt Installation Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

9. Install the camshaft bearing cap bolts in sequence.

Tighten:

1. Alternately hand tighten the camshaft bearing cap bolts a few turns at a time until all caps are fully seated.
2. Tighten the camshaft bearing cap bolts to 5 N.m (44 lb in).
3. Tighten the camshaft bearing cap bolts an additional 30 degrees using the **J 45059**

NOTE: Refer to Torque Reaction Against Timing Drive Chain Notice .

10. Align the camshafts.

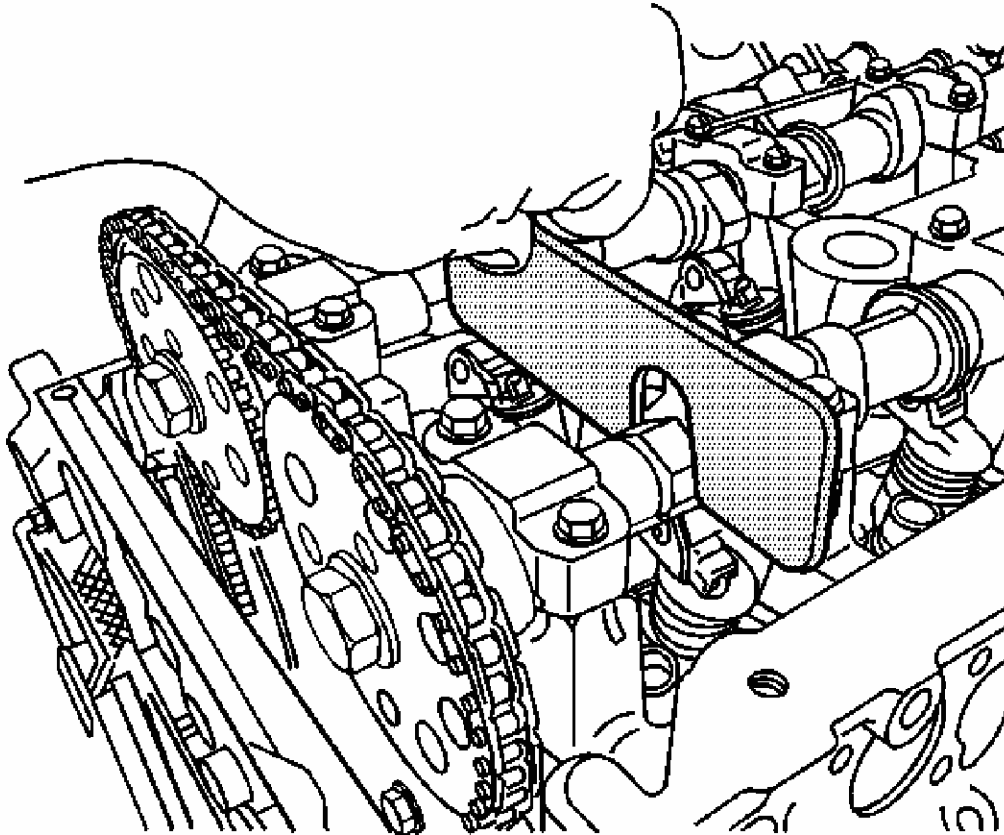


Fig. 280: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Camshaft Holding Tool Caution .

11. Install the **J 44212** over the camshafts. See Special Tools .

IMPORTANT: Ensure the camshaft sprockets properly engage the camshaft sprocket drive pins and camshafts.

12. Install the intake and exhaust camshaft sprockets aligning the paint marks made during disassembly. Ensure that the camshaft sprockets align with the pins of the camshafts.

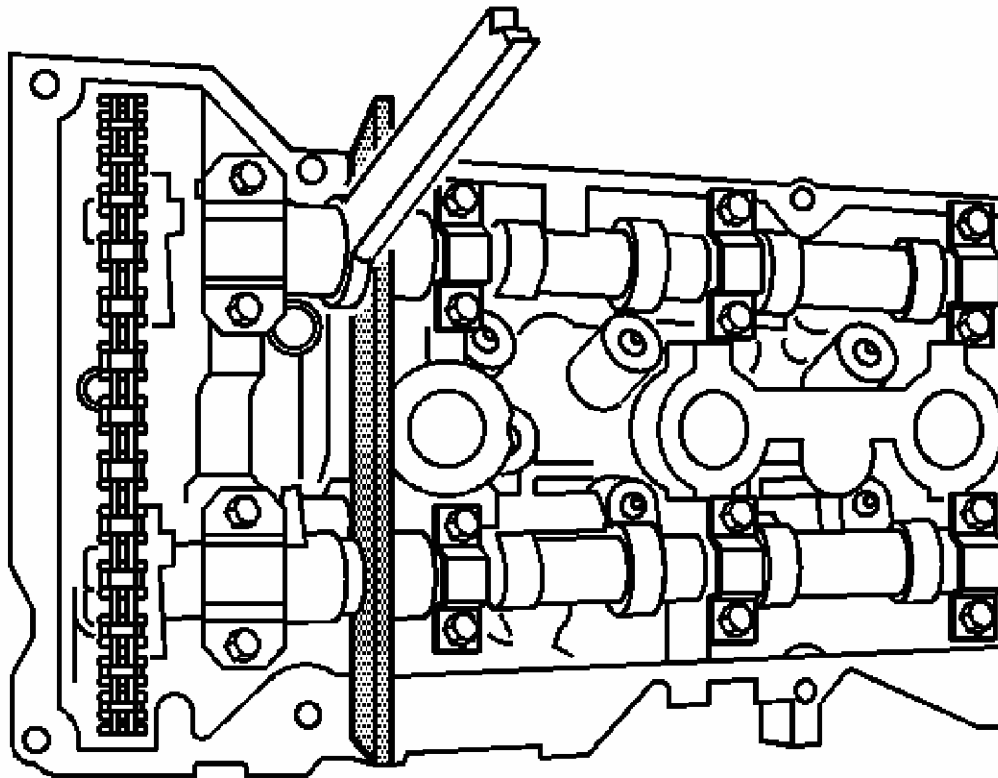


Fig. 281: Holding Camshaft
Courtesy of GENERAL MOTORS CORP.

13. Use an open wrench on the hex cast into the camshafts in order to prevent the camshafts from rotating when tightening the camshaft sprocket bolts.

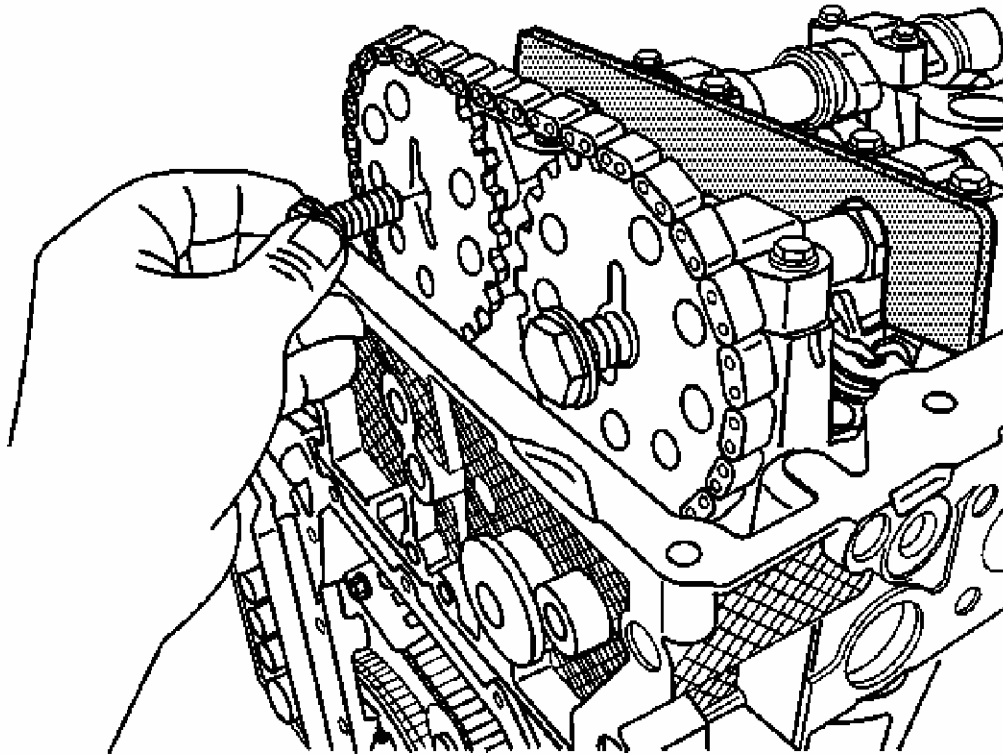


Fig. 282: Identifying Left Intake Camshaft Sprocket Bolt
Courtesy of GENERAL MOTORS CORP.

14. Install the camshaft sprocket bolts.

Tighten: Tighten the camshaft sprocket bolts to 120 N.m (89 lb ft).

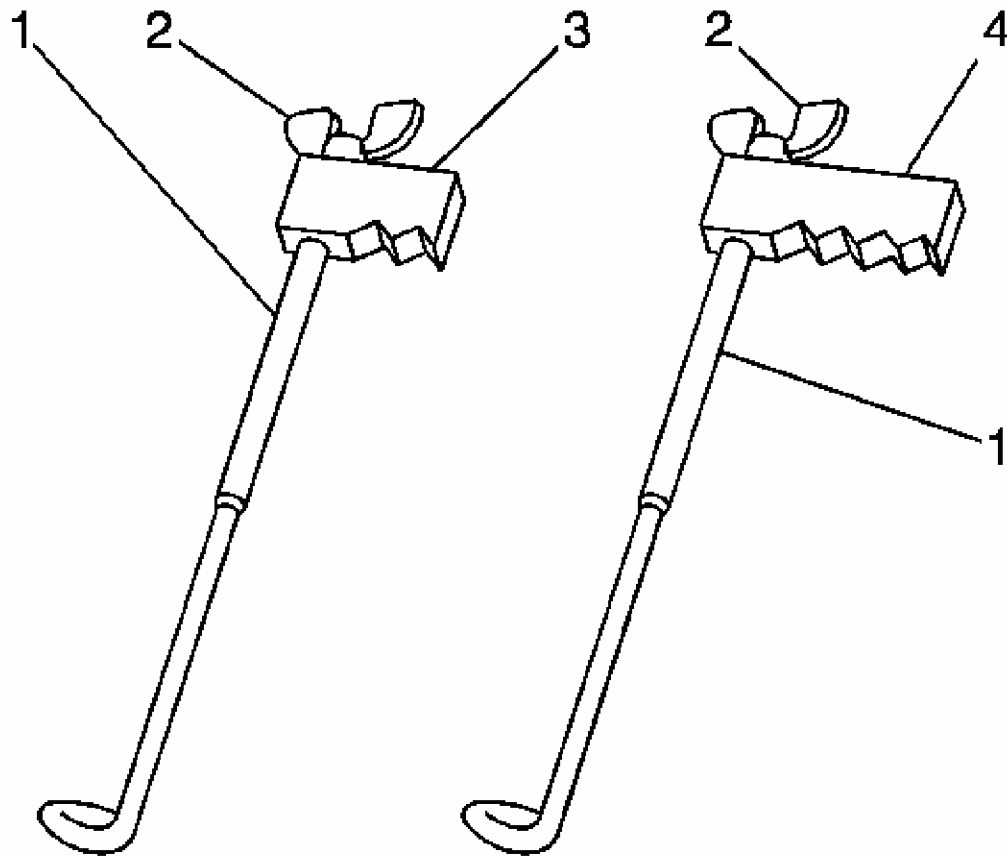


Fig. 283: Identifying Timing Chain Retention Tool Components
Courtesy of GENERAL MOTORS CORP.

15. Remove the **EN 46327** (1). See **Special Tools** .

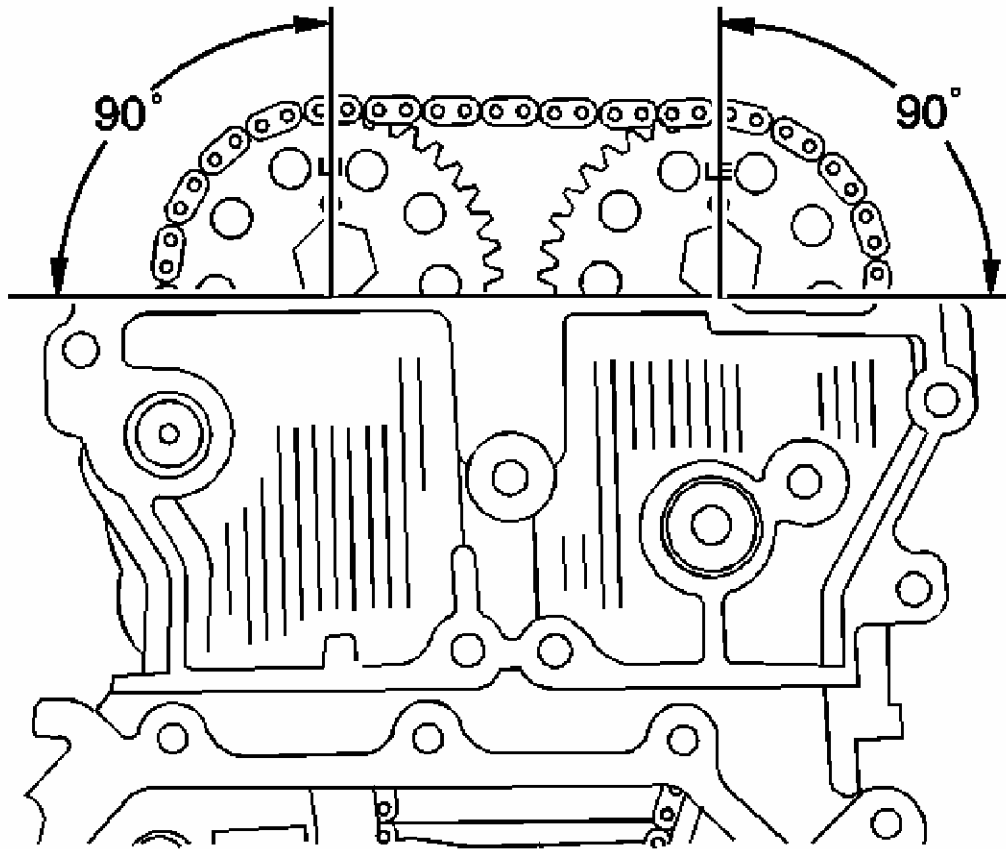


Fig. 284: Ensuring Camshaft Sprocket Drive Pins Are At The Top Of Their Rotation

Courtesy of GENERAL MOTORS CORP.

16. Verify the camshaft sprocket alignment.

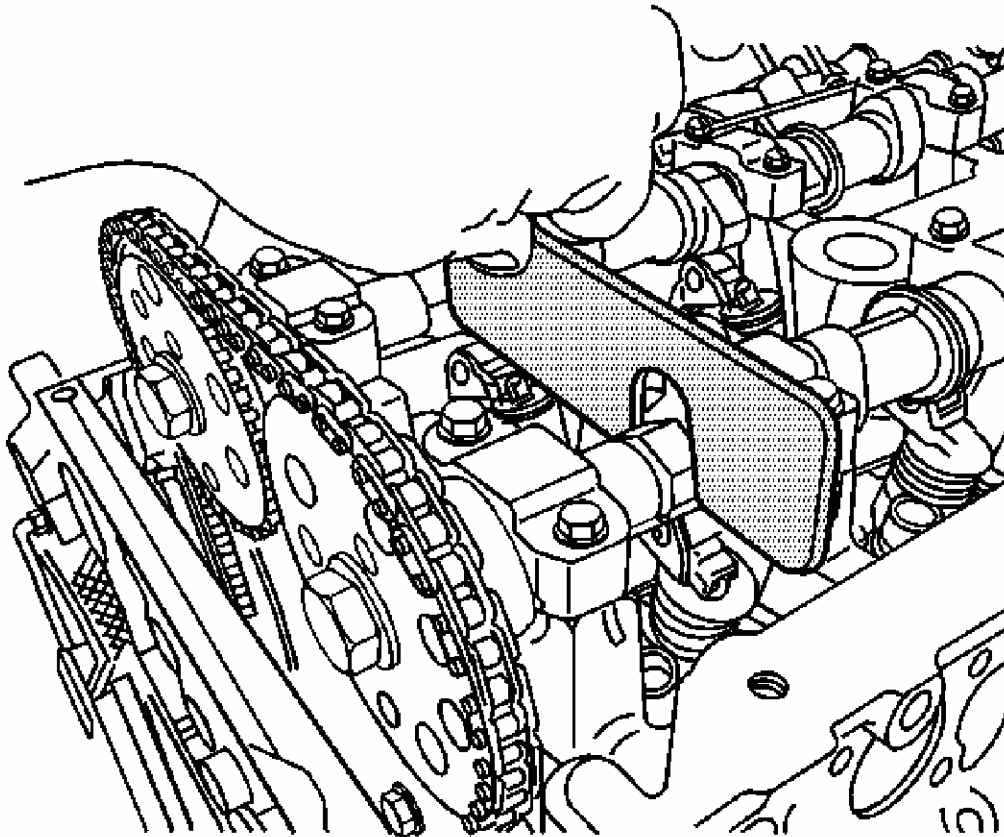


Fig. 285: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS CORP.

17. Remove the **J 44212** from the camshafts. See **Special Tools** .
18. Install the left camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.

CAMSHAFT REPLACEMENT - RIGHT SIDE

TOOLS REQUIRED

- **EN 46327** Timing Chain Retention Tool. See **Special Tools** .
- **J 45059** Angle Meter
- **J 44212** Camshaft Holding Tool. See **Special Tools** .

REMOVAL PROCEDURE

1. Remove the right camshaft cover. Refer to **Camshaft Cover Replacement - Right**

Side.

2. Remove the camshaft position sensor. Refer to **Camshaft Position Sensor Replacement** .

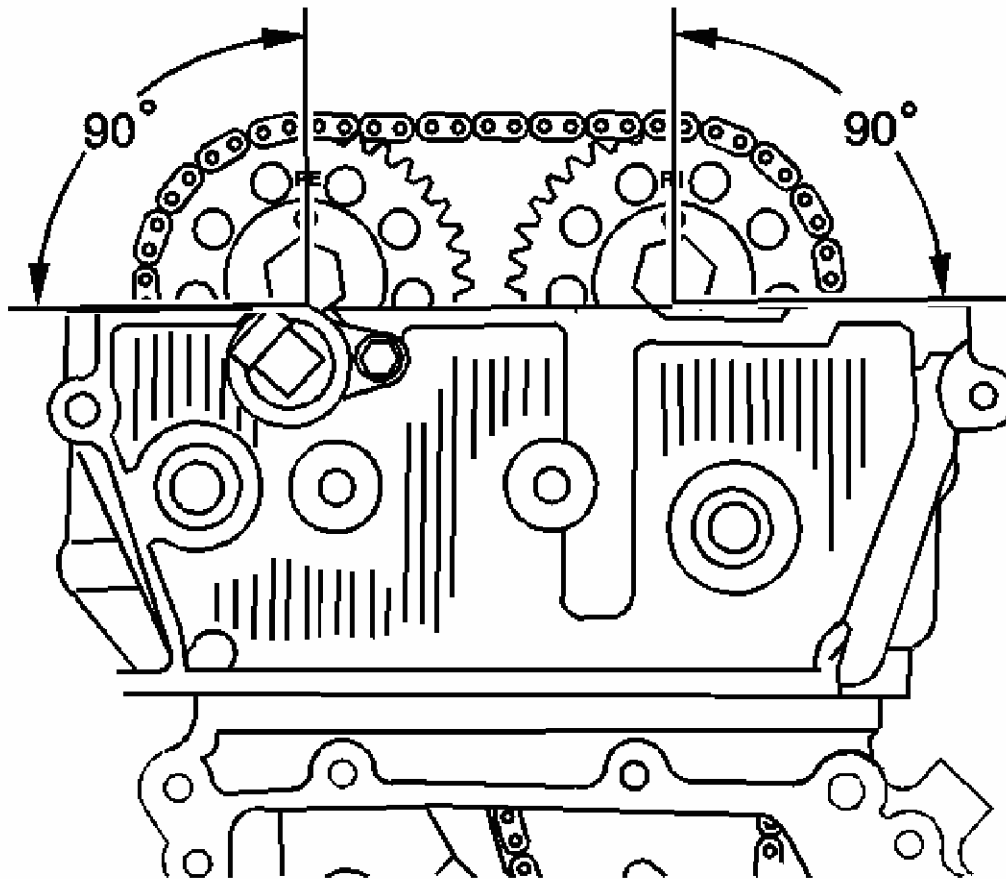


Fig. 286: Ensuring Camshaft Sprocket Drive Pins Are At Top Of Their Rotation
Courtesy of GENERAL MOTORS CORP.

3. Rotate the crankshaft to TDC of the # 1 cylinders compression stroke, both camshaft sprocket drive pins should be at the top of their rotation.

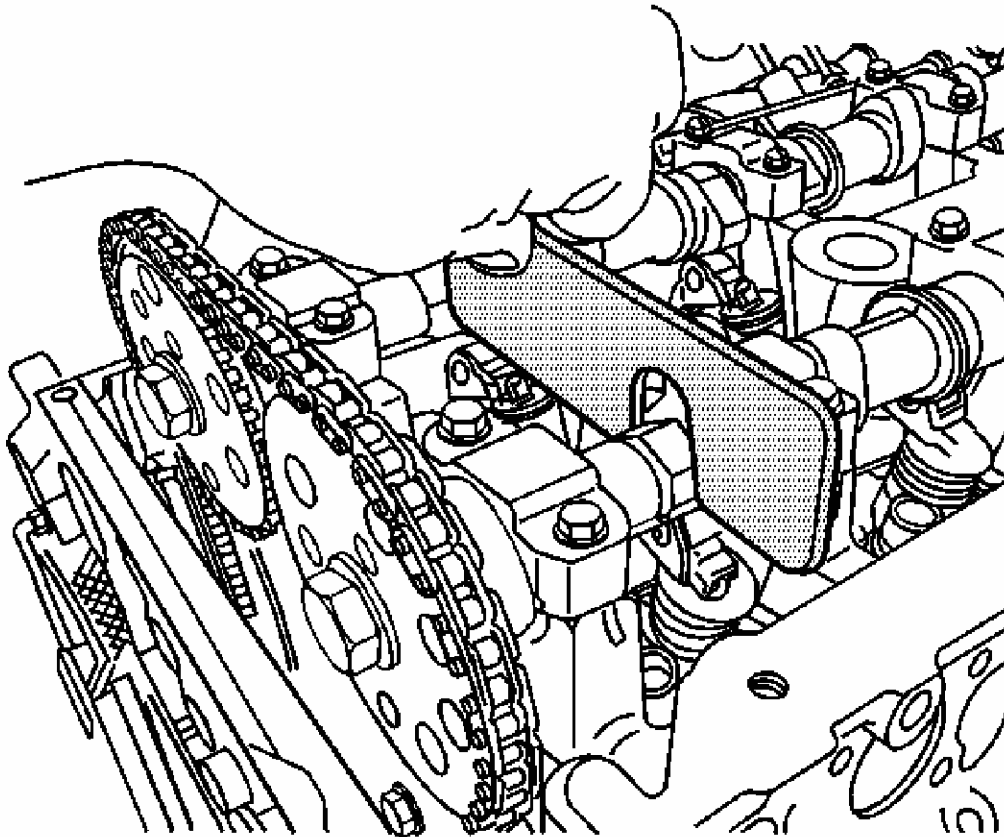


Fig. 287: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Camshaft Holding Tool Caution .

4. Install the **J 44212** over the camshafts. See Special Tools .

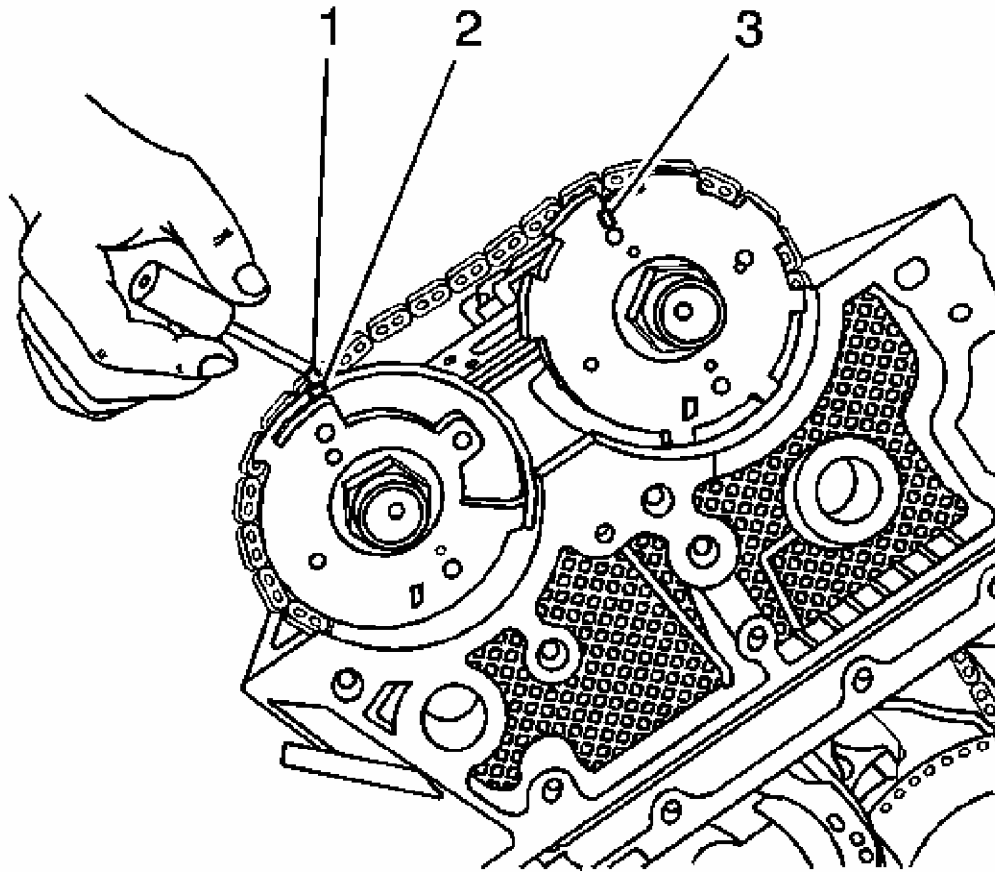


Fig. 288: Using A Paint Stick To Create A Mark On The Timing Chain Link Adjacent To Each Camshaft Sprocket Timing Mark
Courtesy of GENERAL MOTORS CORP.

5. Use a paint stick to create a mark (1) on the timing chain link adjacent to each camshaft sprocket timing mark (2, 3).

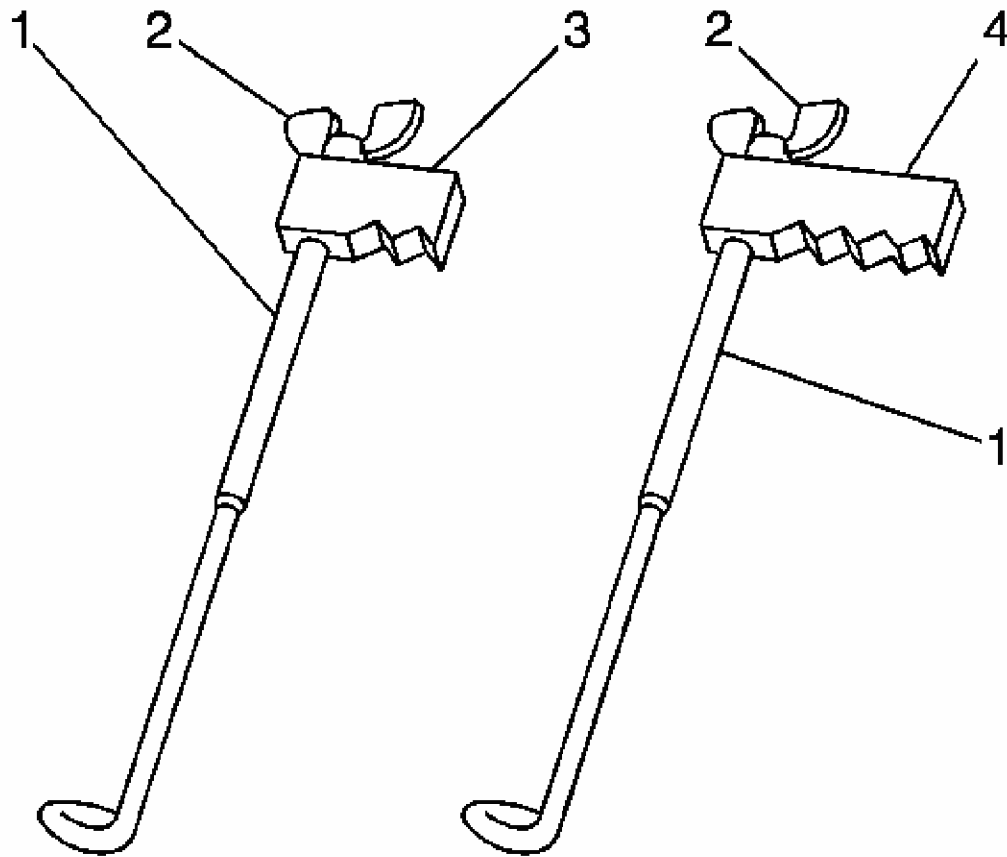


Fig. 289: Identifying Timing Chain Retention Tool Components
Courtesy of GENERAL MOTORS CORP.

6. Install both **EN 46327** (1) to the engine using the following step:. See **Special Tools** .
Rotate the wing nut (2) of the **EN 46327** (3) to the top of its travel. See **Special Tools** .

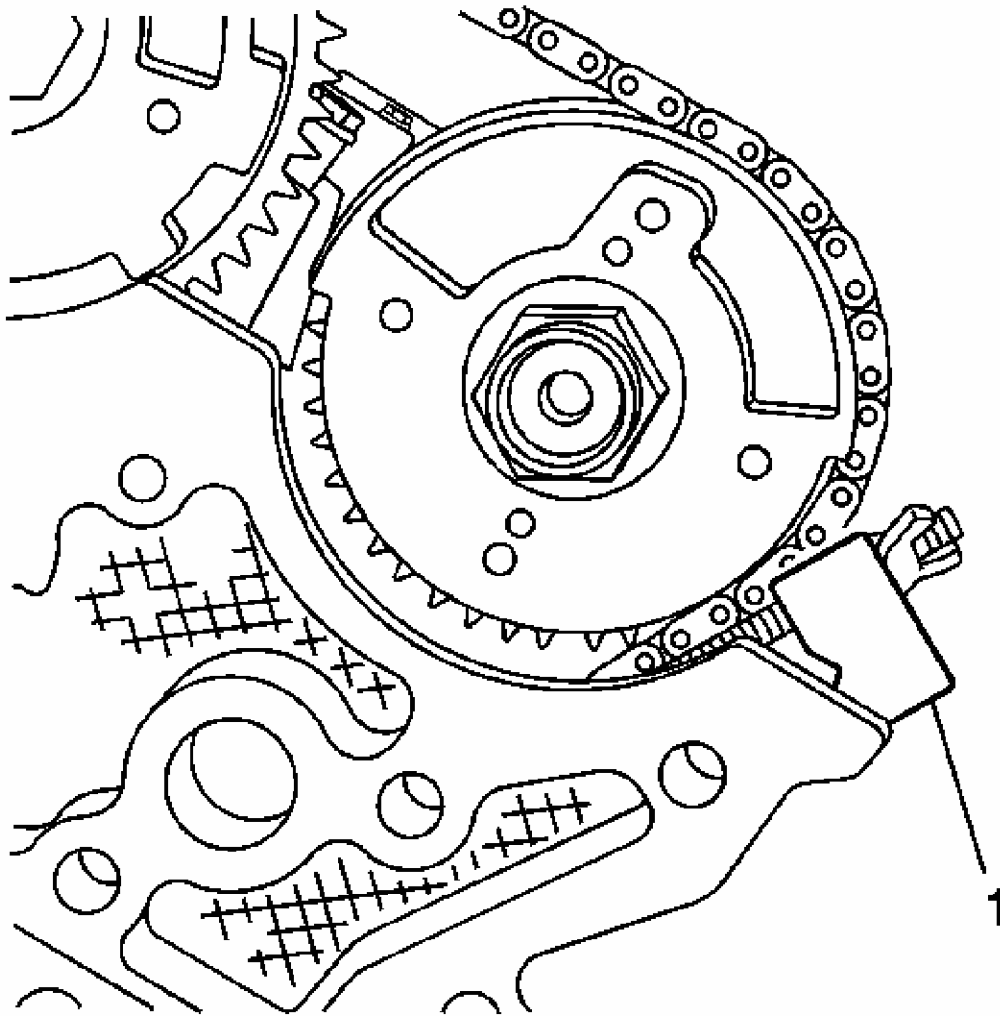


Fig. 290: Positioning EN 46327 On The Cylinder Head
Courtesy of GENERAL MOTORS CORP.

7. Position the bottom retention tool on the cylinder head with the V-notch of the block (1) adjacent to the right exhaust camshaft sprocket and chain.

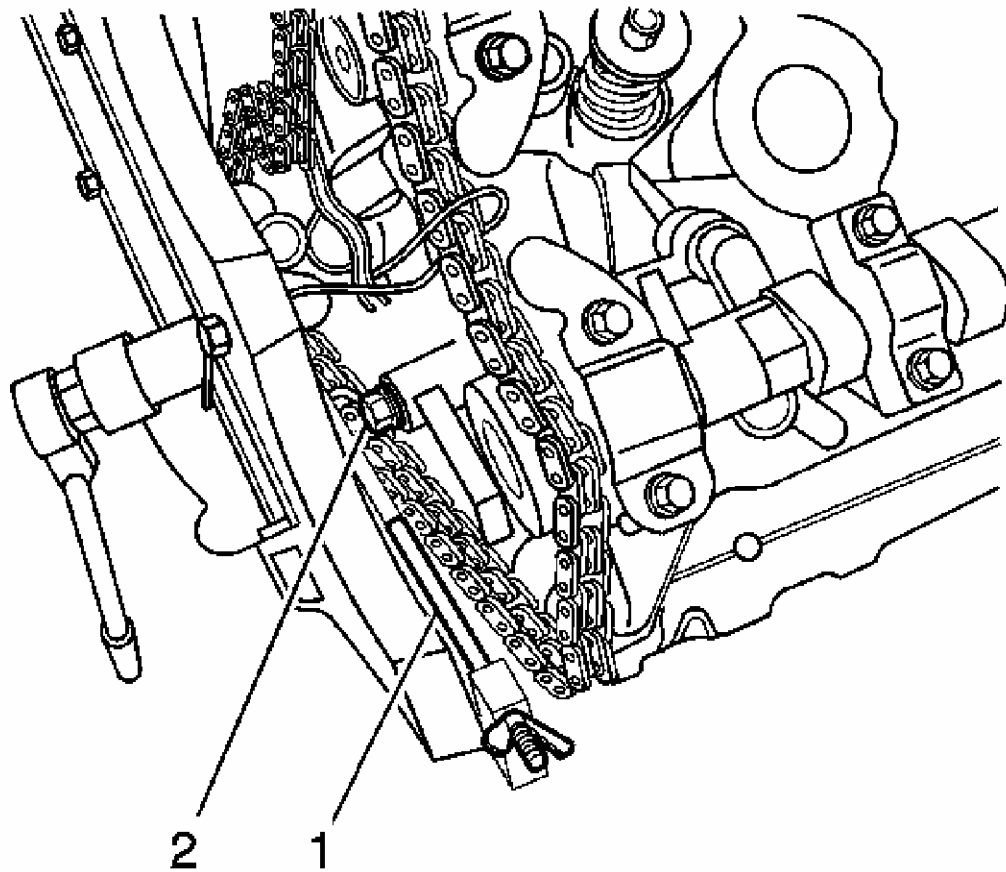


Fig. 291: Installing EN 46327 Hook End Into Secondary Timing Chain Link
Courtesy of GENERAL MOTORS CORP.

8. Insert the hook end (2) into a secondary timing chain link as shown.

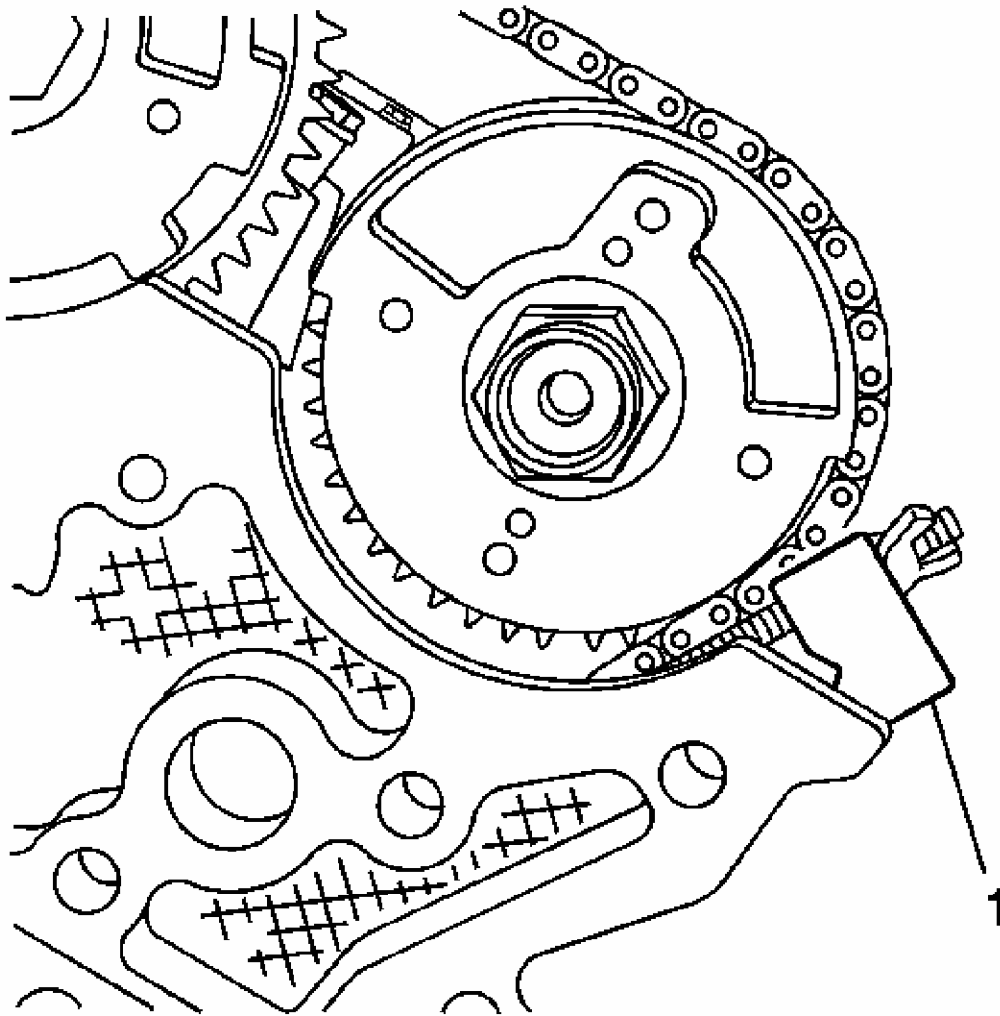


Fig. 292: Positioning EN 46327 On The Cylinder Head
Courtesy of GENERAL MOTORS CORP.

9. Rotate the wing nut until it contacts the retention tool block (1). DO NOT tighten the wing nut at this time.

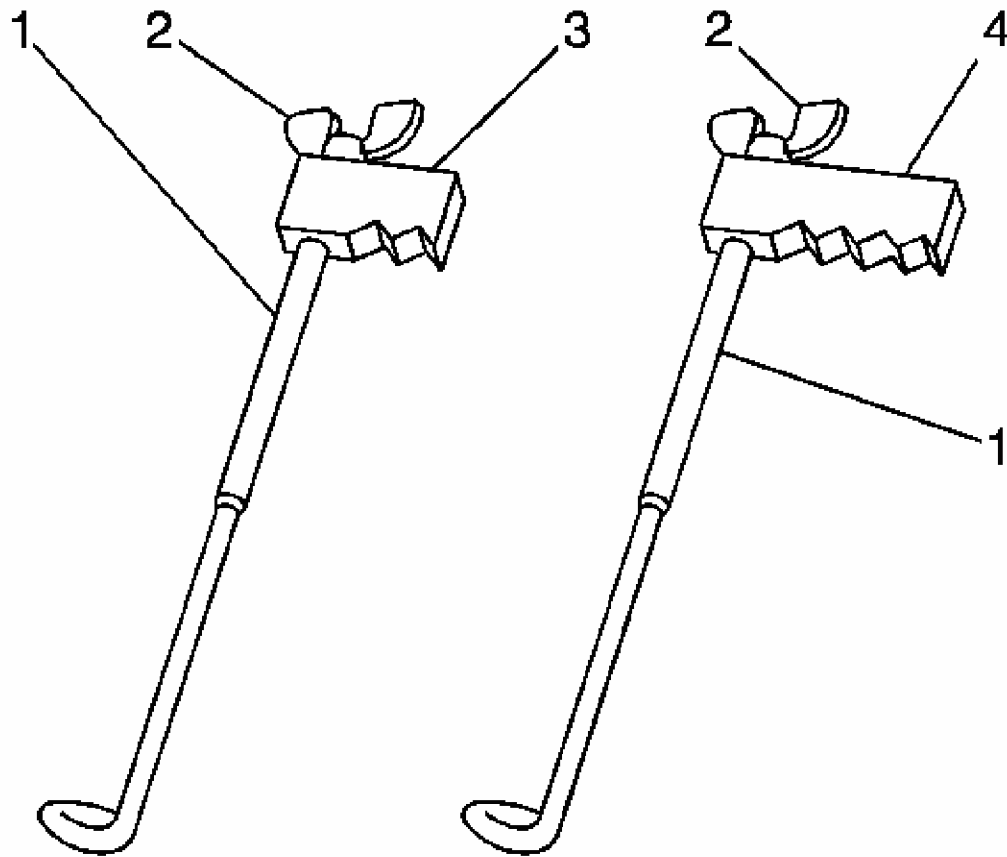


Fig. 293: Identifying Timing Chain Retention Tool Components
Courtesy of GENERAL MOTORS CORP.

10. Rotate the wing nut (2) of the **EN 46327** (4) to the top of its travel. See **Special Tools** .

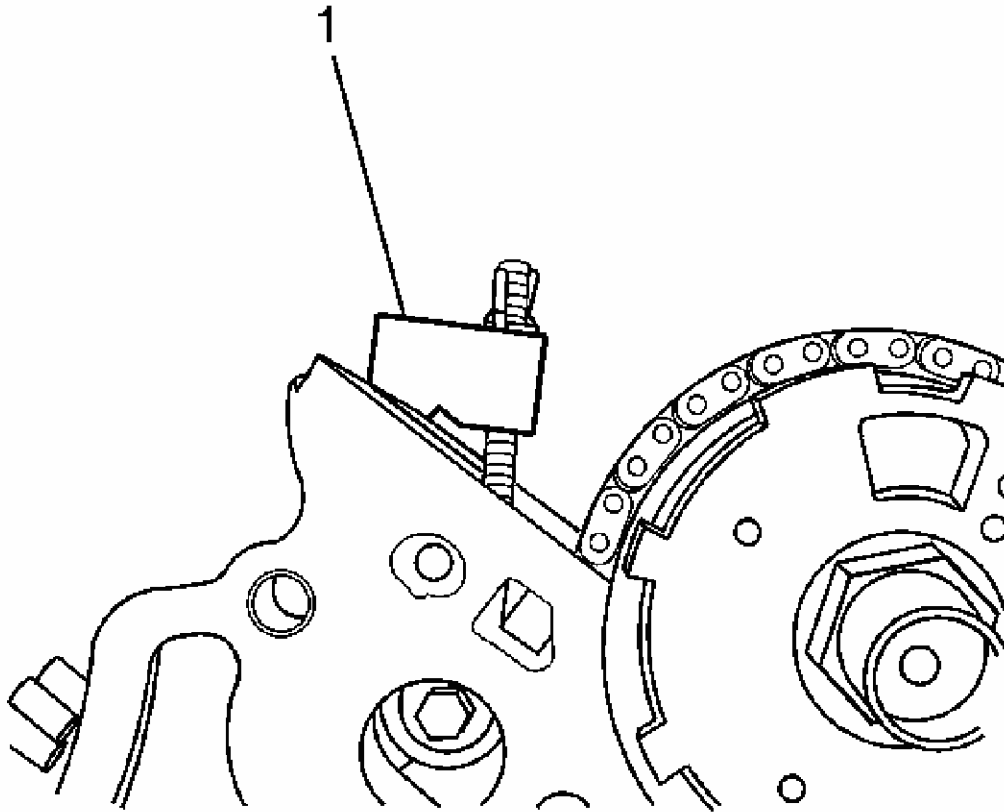


Fig. 294: Positioning Top Retention Tool On Cylinder Head
Courtesy of GENERAL MOTORS CORP.

11. Position the top retention tool on the cylinder head with the V-notch of the block (1) adjacent to the right intake camshaft sprocket and chain.

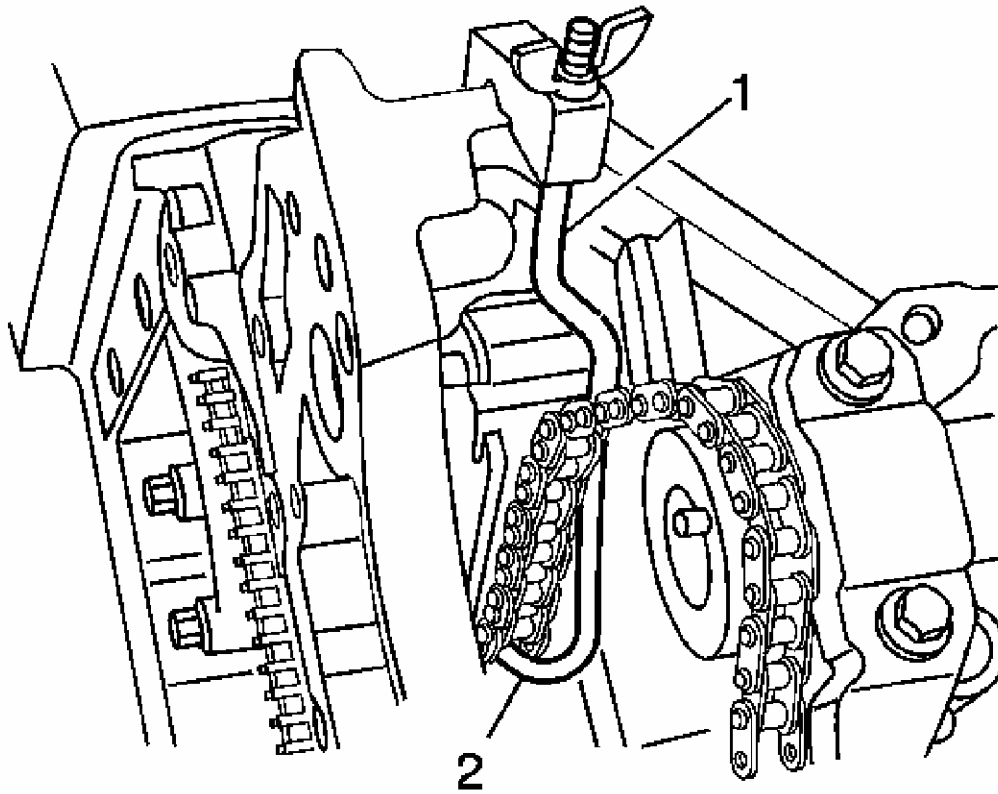


Fig. 295: View Of Hook End In Secondary Timing Chain Link
Courtesy of GENERAL MOTORS CORP.

12. Insert the hook end (2) into a secondary timing chain link as shown.

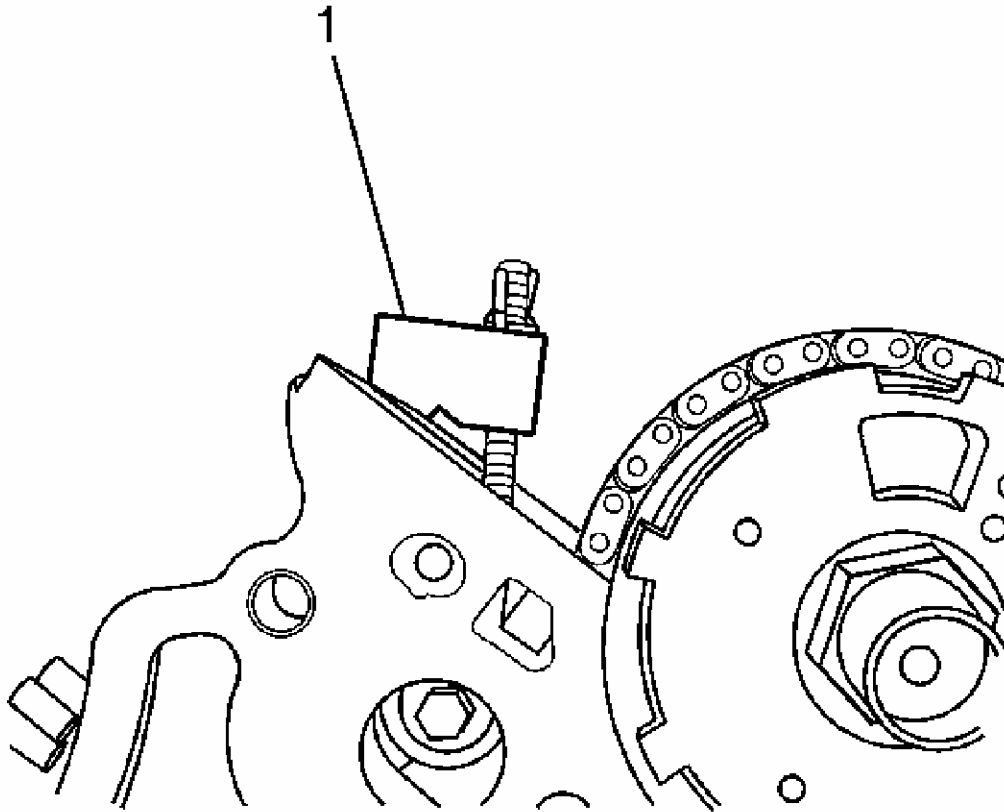


Fig. 296: Positioning Top Retention Tool On Cylinder Head
Courtesy of GENERAL MOTORS CORP.

13. Rotate the wing nut until it contacts the retention tool block (1). Alternately tighten both wing nuts to retain the chain.

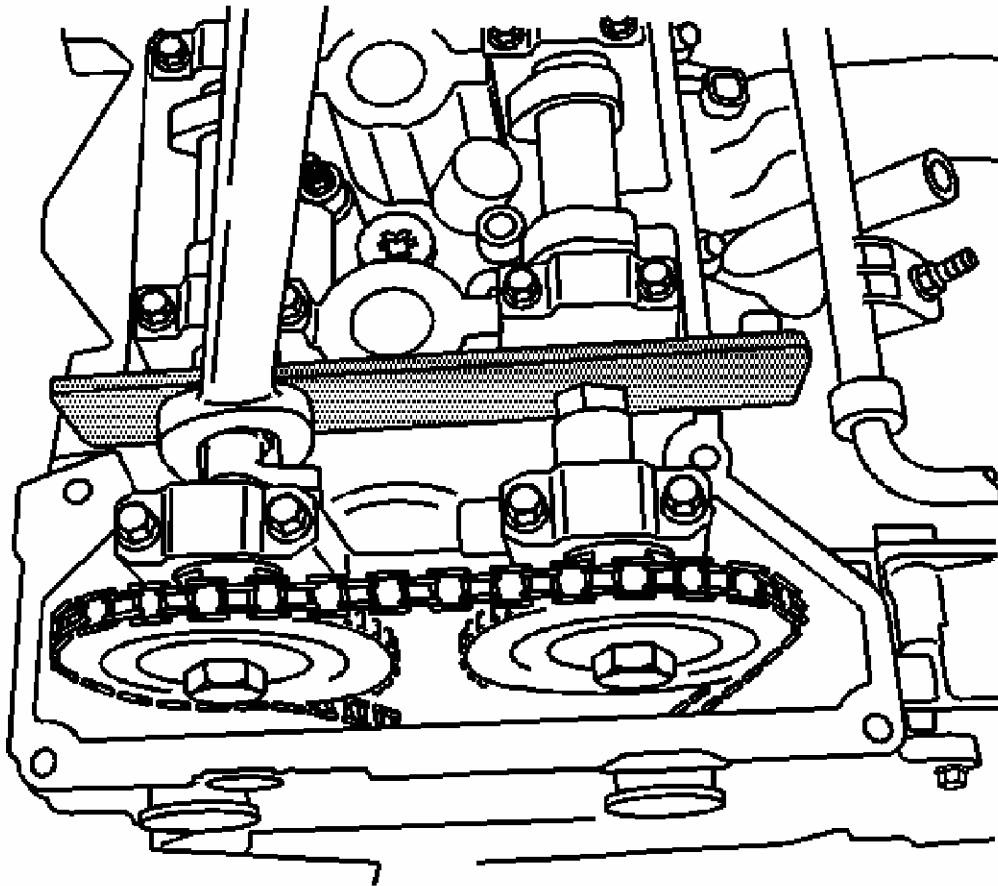


Fig. 297: Securing Camshaft Using An Open End Wrench
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Torque Reaction Against Timing Drive Chain Notice .

14. Use an open wrench on the hex cast into the camshafts in order to prevent the camshafts from rotating when removing the camshaft sprocket bolts.

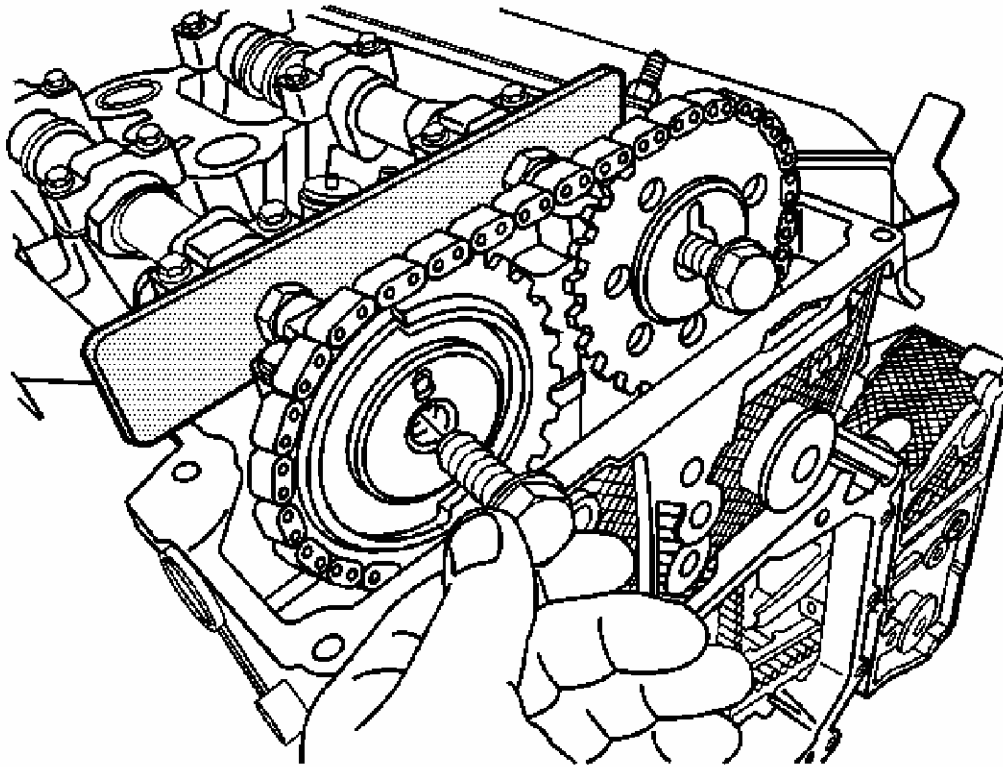


Fig. 298: Identifying Right Exhaust Camshaft Sprocket Bolt
Courtesy of GENERAL MOTORS CORP.

15. Remove the camshaft sprocket bolts.
16. Remove the camshaft sprockets.

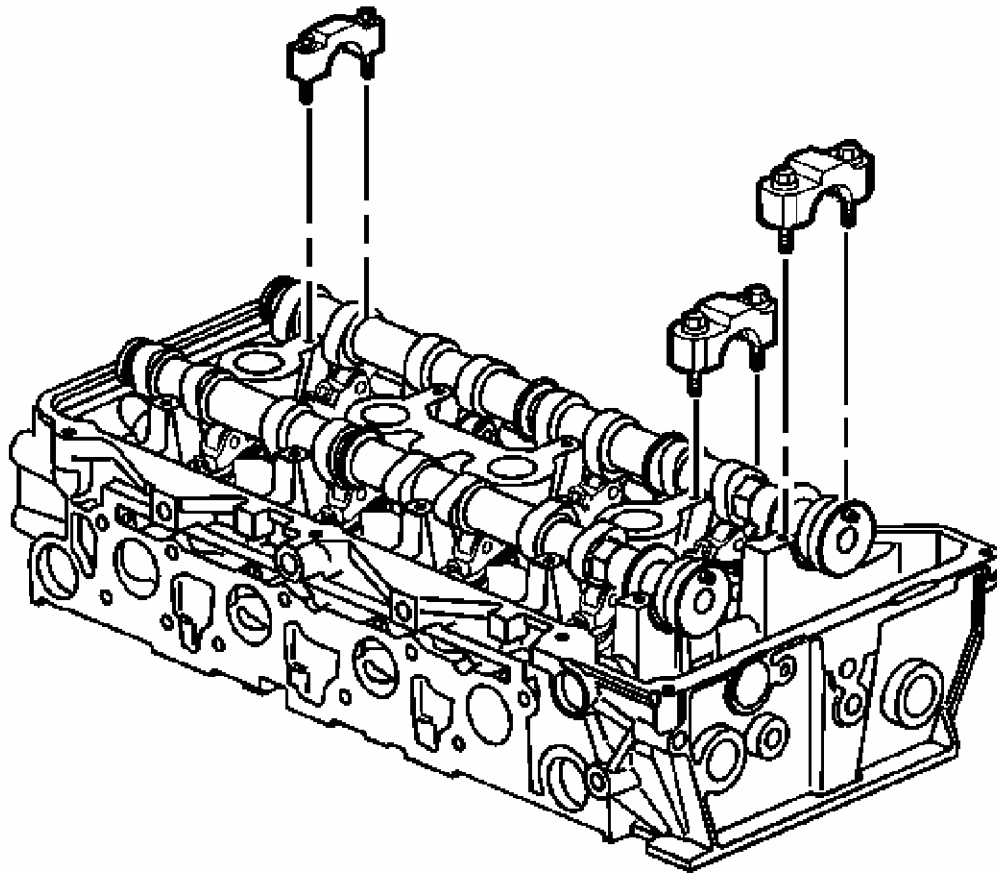


Fig. 299: View of Camshaft Bearing Cap
Courtesy of GENERAL MOTORS CORP.

17. Alternately loosen the camshaft bearing cap bolts a few turns at a time until all valve spring pressure has been released.
18. Remove the camshaft bearing caps.
19. Remove the **J 44212** from the camshafts. See **Special Tools** .

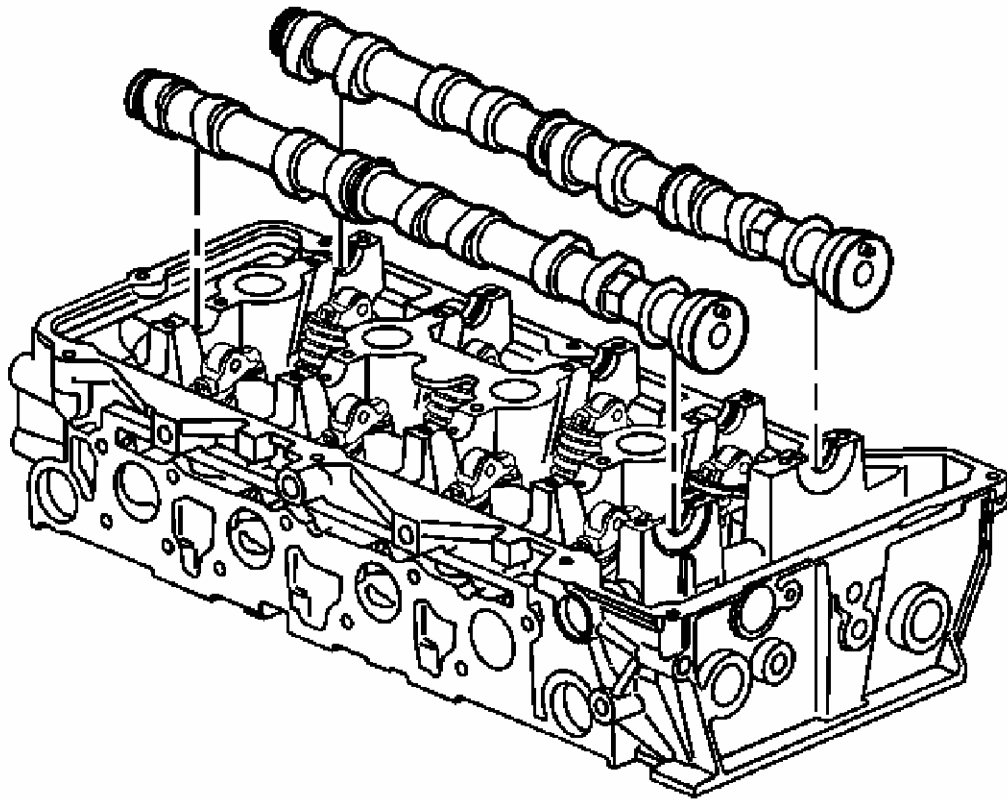


Fig. 300: View of Camshafts
Courtesy of GENERAL MOTORS CORP.

20. Remove the camshafts.

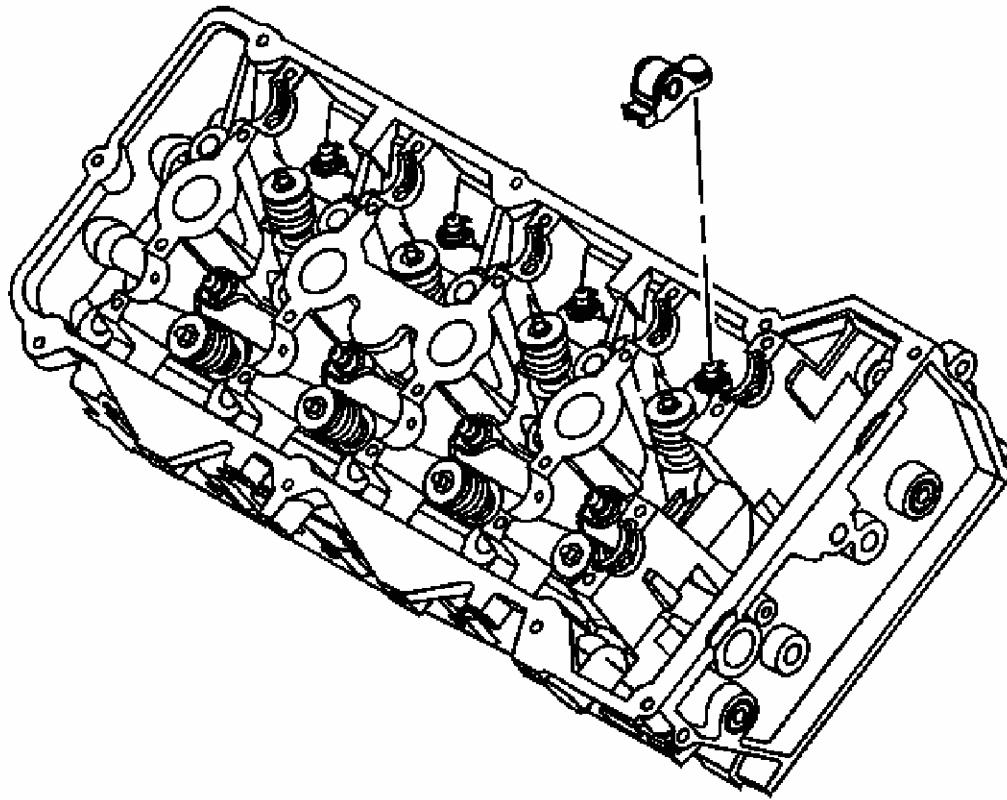


Fig. 301: View of Camshaft Followers
Courtesy of GENERAL MOTORS CORP.

21. Remove the camshaft followers.
22. Clean and inspect the camshafts. Refer to **Camshaft Cleaning and Inspection** .

INSTALLATION PROCEDURE

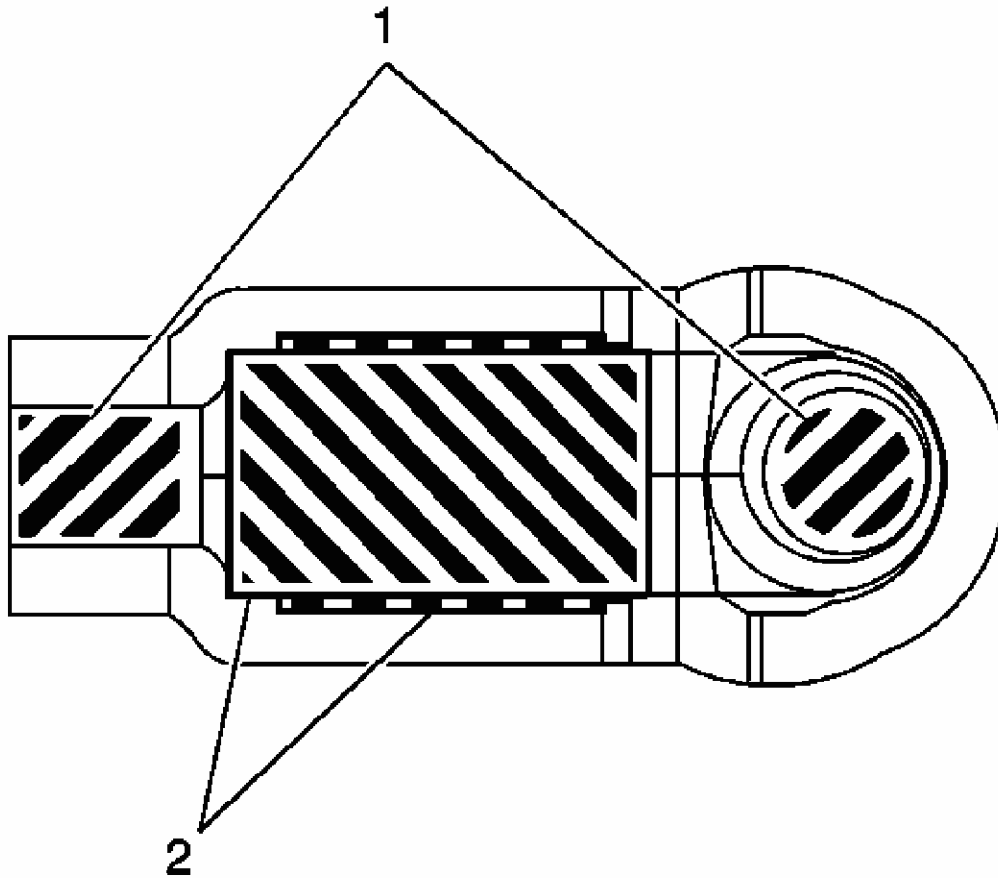


Fig. 302: Identifying Roller Pivot Pocket (2) & Valve Slot Areas (1) Of Camshaft Followers

Courtesy of GENERAL MOTORS CORP.

1. Apply a liberal amount of lubricant to the roller pivot pocket (2) and valve slot areas (1) of the camshaft followers. Refer to **Sealers, Adhesives and Lubricants** .

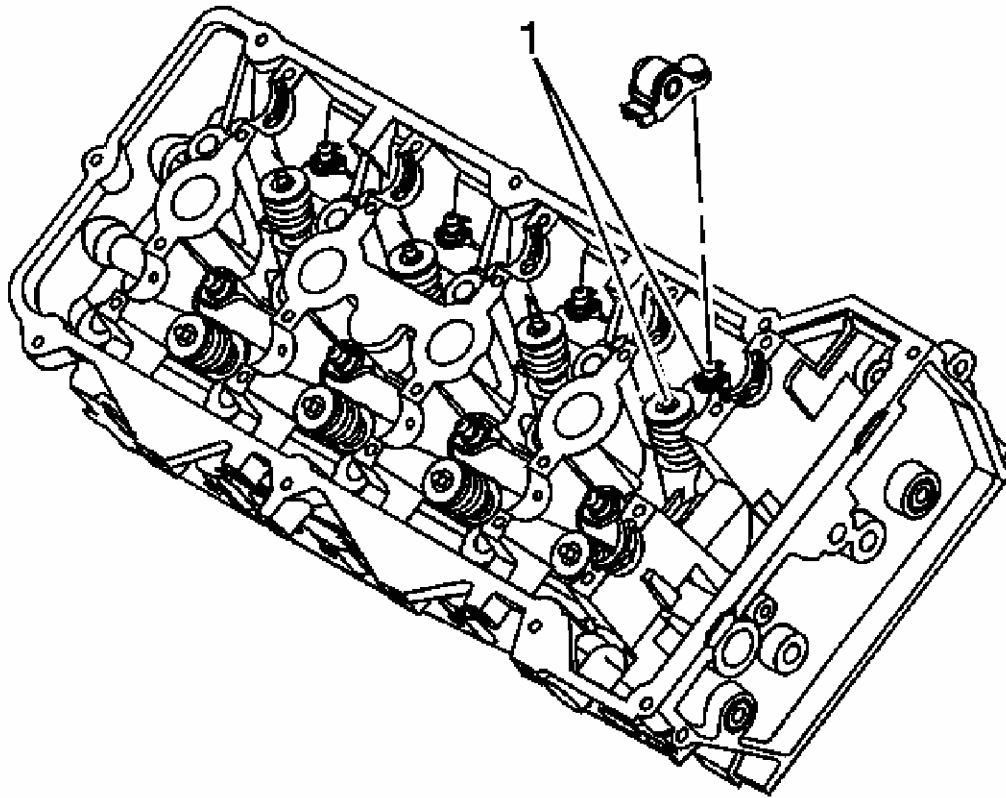


Fig. 303: Identifying Stationary Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The follower must be positioned squarely on the valve tip so that the full width of the roller will completely contact the camshaft lobe. If the followers are being reused you must put them back in their original location.

2. Place the camshaft followers in position on the valve tip and the stationary hydraulic lash adjusters (SHLA) (1). The rounded head of the follower goes on the SHLA, while the flat end goes on the valve tip.
3. Clean the camshaft carriers with a clean, lint-free cloth.

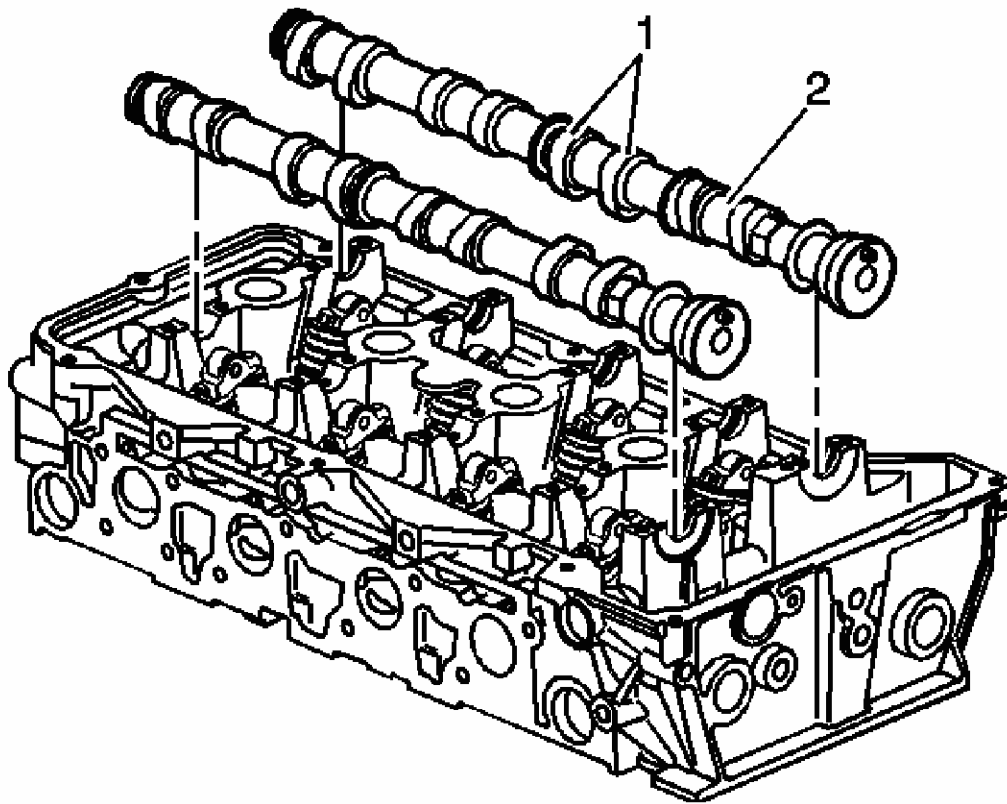


Fig. 304: Identifying Camshaft Lobes & Journals
Courtesy of GENERAL MOTORS CORP.

4. Apply a liberal amount of lubricant to the camshaft carriers, camshaft lobes (1) and the camshaft journals (2). Refer to **Sealers, Adhesives and Lubricants** .
5. Place the camshaft in the camshaft carriers with the camshaft sprocket drive pins near the top of their rotation and the camshaft lobes in a neutral position. The camshafts can be identified by a stamping near the rear journal. For example: R-EXH is defined as Right bank Exhaust.

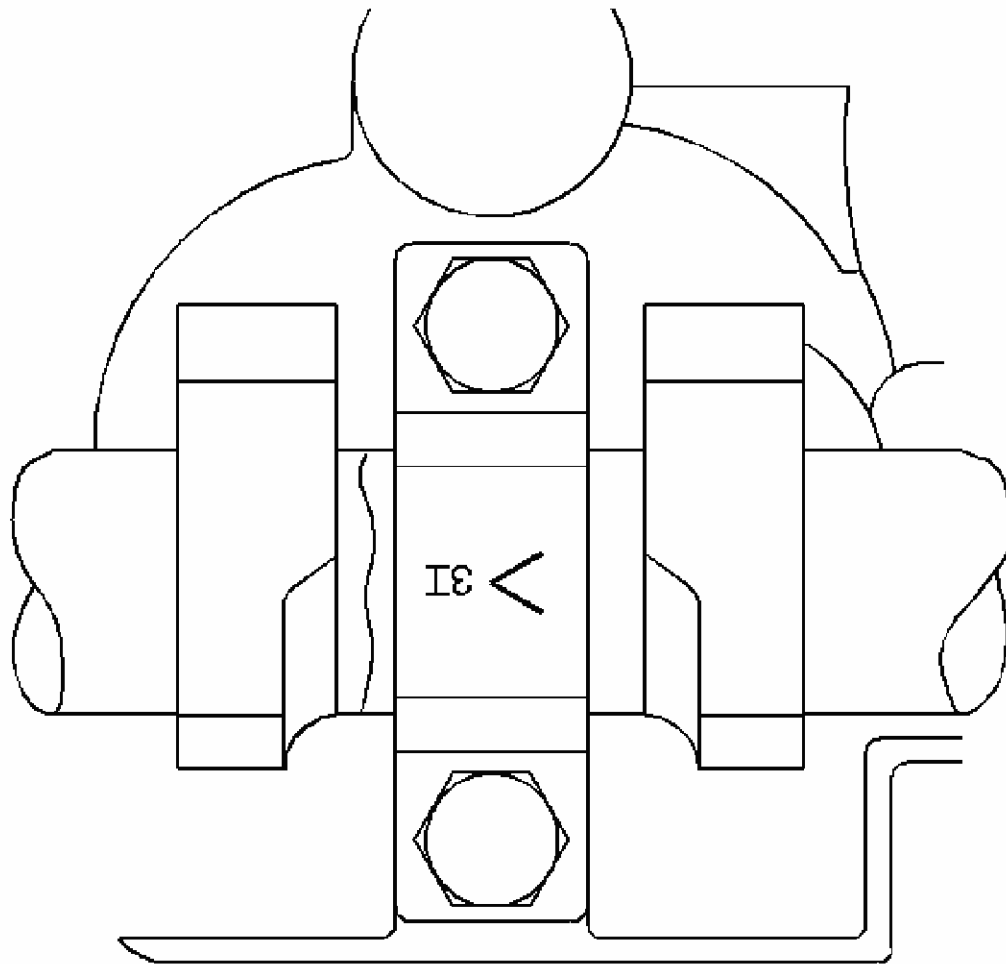


Fig. 305: Identifying Camshaft Bearing Cap Markings
Courtesy of GENERAL MOTORS CORP.

6. Observe the markings on the camshaft bearing caps. Each camshaft bearing cap is marked in order to identify its location. The markings have the following meanings:
 - The arrow should point to the front of the engine.
 - The number indicates the position from the front of the engine.
 - The "E" indicates the exhaust camshaft.
 - The "I" indicates the Intake camshaft.
7. Apply a liberal amount of lubricant to the camshaft bearing caps. Refer to **Sealers, Adhesives and Lubricants** .

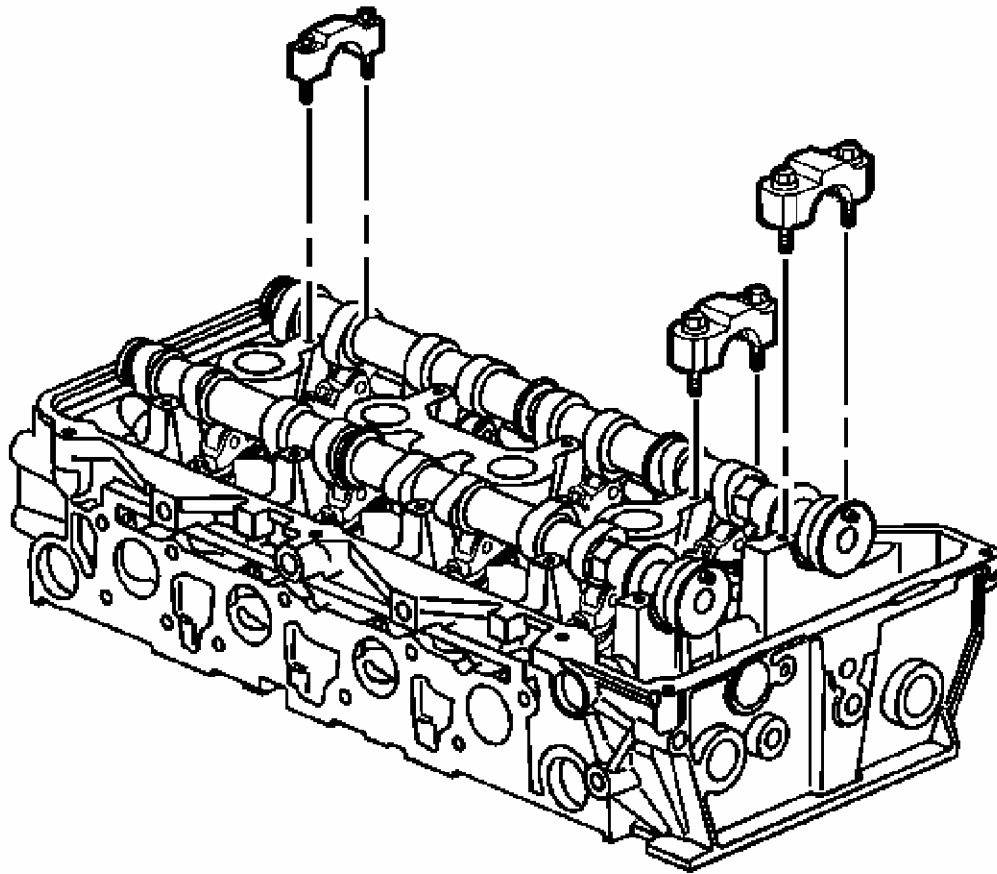


Fig. 306: View Of Camshaft Bearing Caps
Courtesy of GENERAL MOTORS CORP.

8. Install the camshaft bearing caps according to the identification marks.

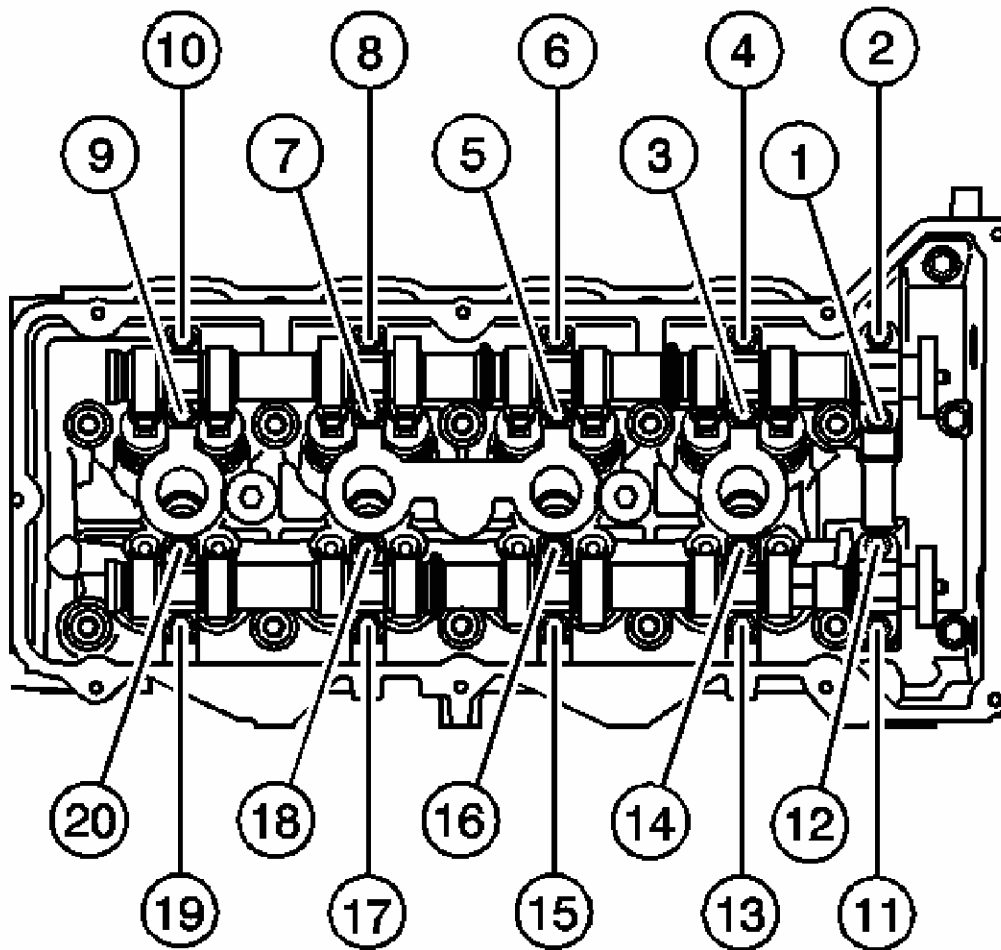


Fig. 307: View Of Right Camshaft Bearing Cap Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

9. Install the camshaft bearing cap bolts in sequence.

Tighten:

1. Alternately hand tighten the camshaft bearing cap bolts a few turns at a time until all caps are fully seated.
2. Tighten the camshaft bearing cap bolts to 5 N.m (44 lb in).
3. Tighten the camshaft bearing cap bolts an additional 30 degrees using the **J 45059** .

NOTE: Refer to Torque Reaction Against Timing Drive Chain

Notice .

10. Align the camshafts.

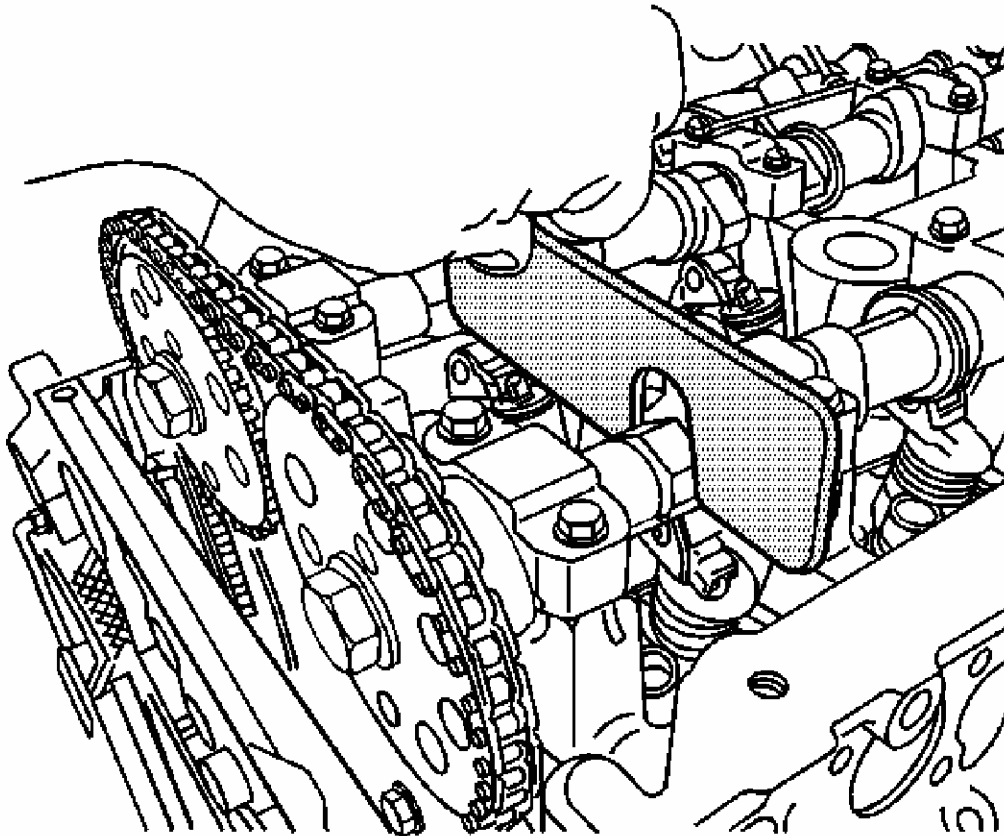


Fig. 308: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Camshaft Holding Tool Caution .

11. Install the **J 44212** over the camshafts. See Special Tools .

IMPORTANT: Ensure the camshaft sprockets properly engage the camshaft sprocket drive pins and camshafts.

12. Install the intake and exhaust camshaft sprockets aligning the paint marks made during disassembly. Ensure that the camshaft sprockets align with the pins of the camshafts.

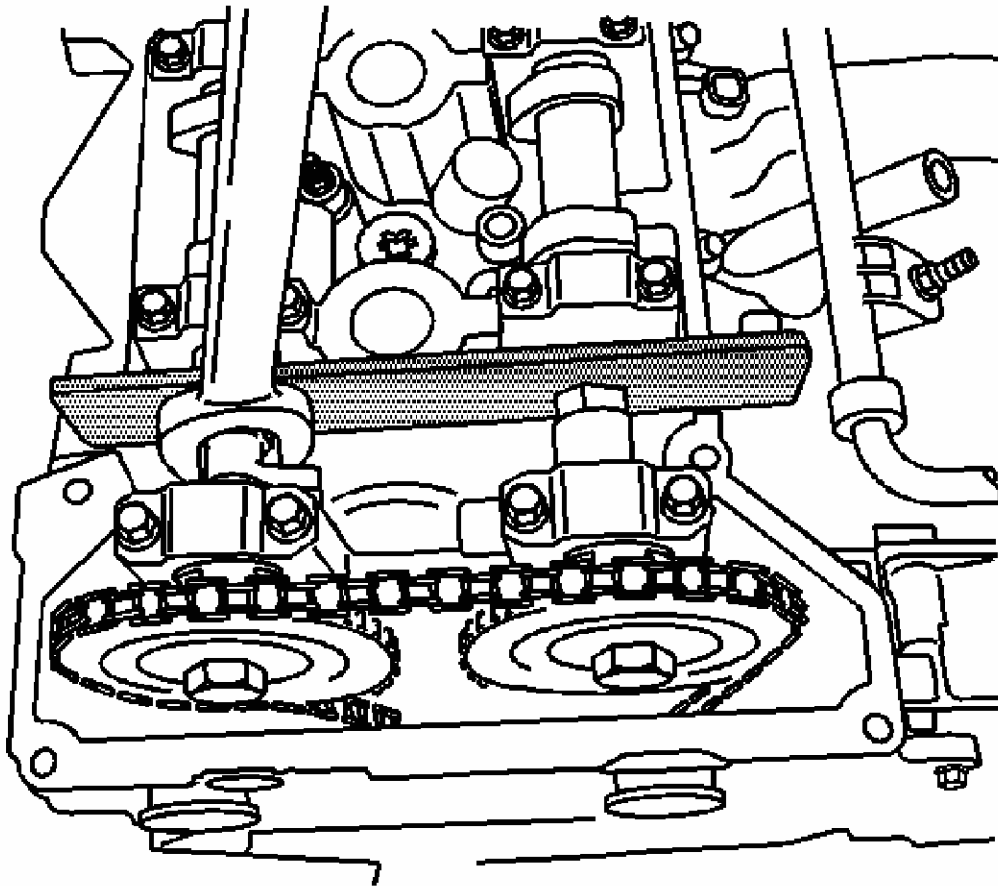


Fig. 309: Securing Camshaft Using An Open End Wrench
Courtesy of GENERAL MOTORS CORP.

13. Use an open wrench on the hex cast into the camshafts in order to prevent the camshafts from rotating when tightening the camshaft sprocket bolts.

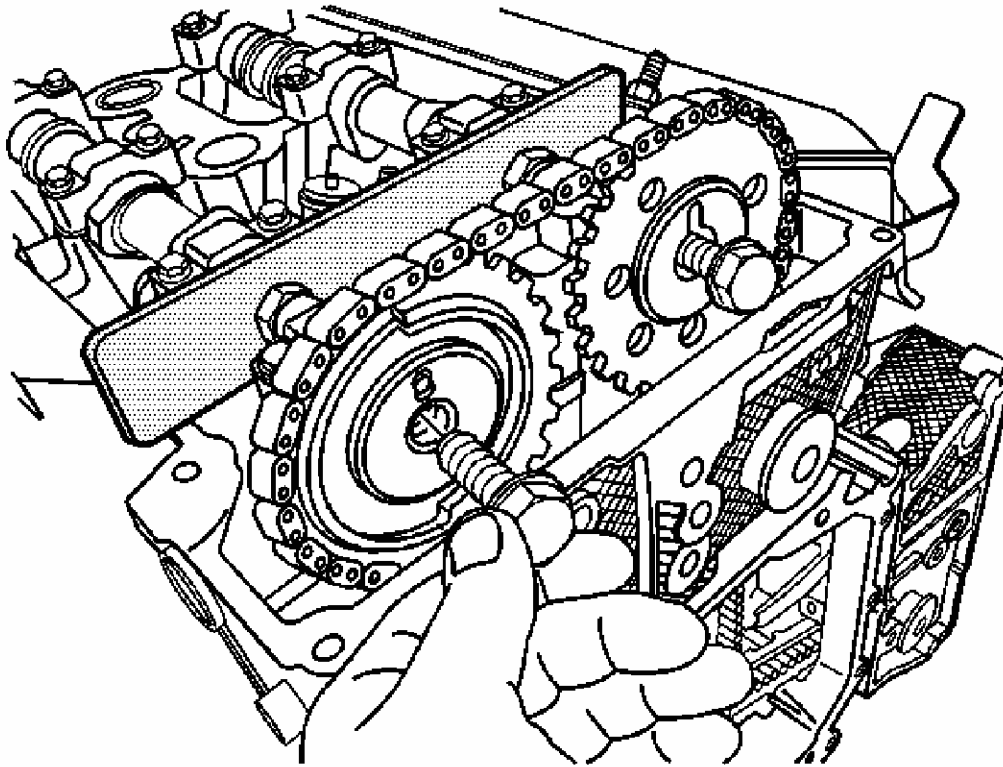


Fig. 310: Identifying Right Exhaust Camshaft Sprocket Bolt
Courtesy of GENERAL MOTORS CORP.

14. Install the camshaft sprocket bolts.

Tighten: Tighten the camshaft sprocket bolts to 120 N.m (89 lb ft).

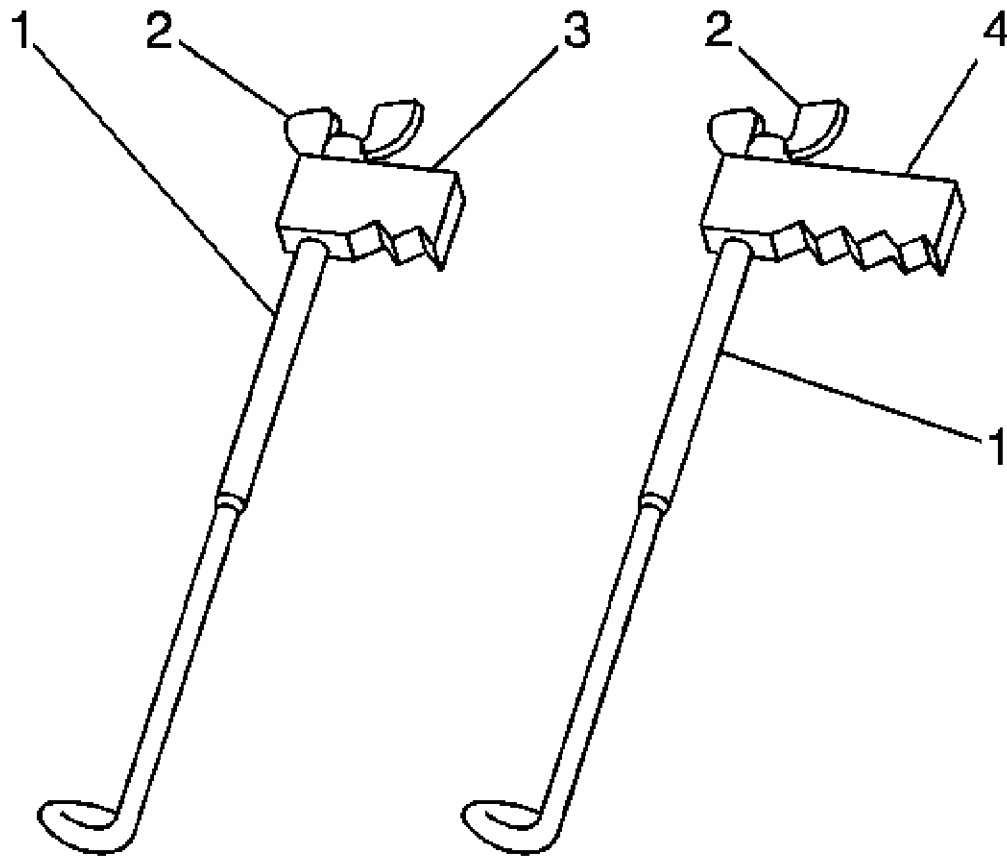


Fig. 311: Identifying Timing Chain Retention Tool Components
Courtesy of GENERAL MOTORS CORP.

15. Remove the **EN 46327** (1). See Special Tools .

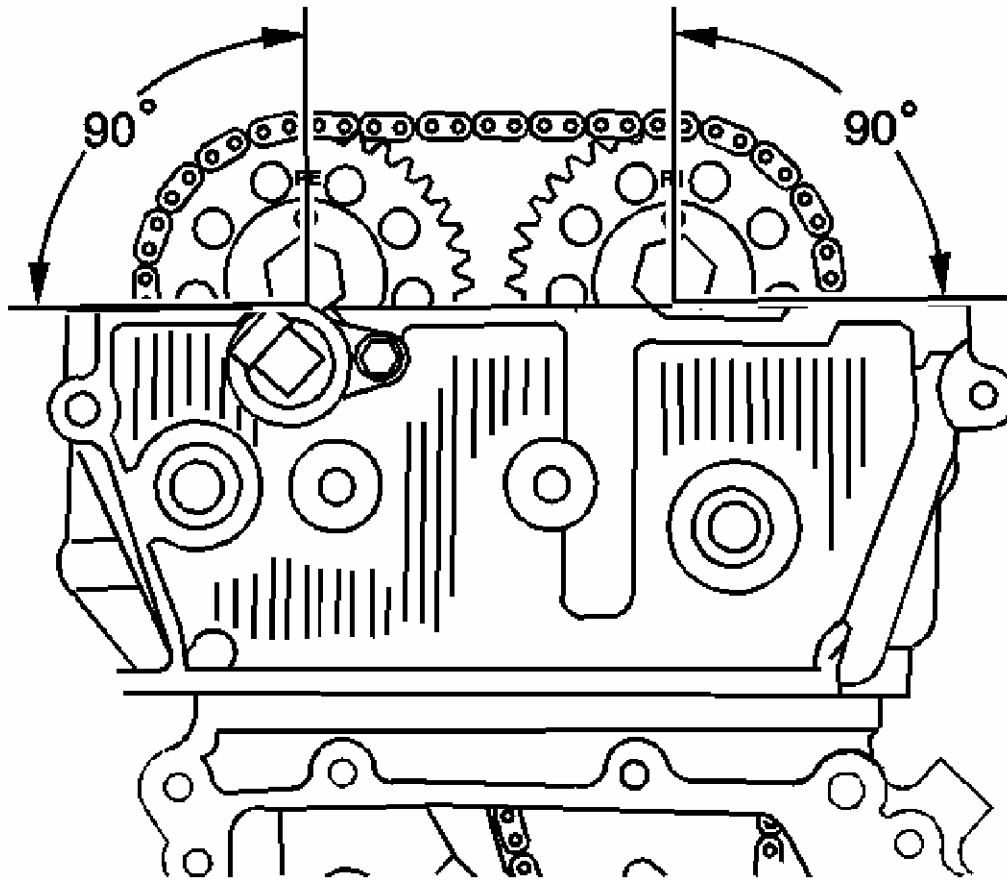


Fig. 312: Ensuring Camshaft Sprocket Drive Pins Are At Top Of Their Rotation
Courtesy of GENERAL MOTORS CORP.

16. Verify the camshaft sprocket alignment.

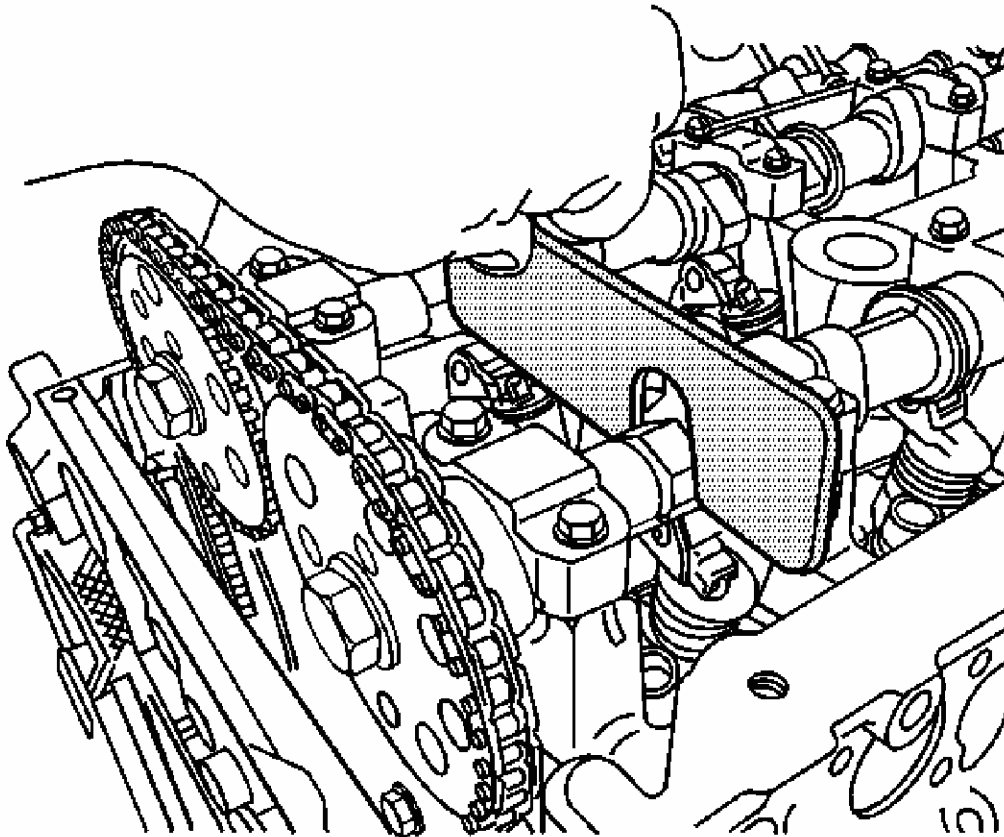


Fig. 313: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS CORP.

17. Remove the **J 44212** from the camshafts. See **Special Tools** .
18. Install the camshaft position sensor. Refer to **Camshaft Position Sensor Replacement** .
19. Install the right camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.

VALVE ROCKER ARM REPLACEMENT - LEFT SIDE

REMOVAL PROCEDURE

1. Remove the left camshafts. Refer to **Camshaft Replacement - Left Side**.

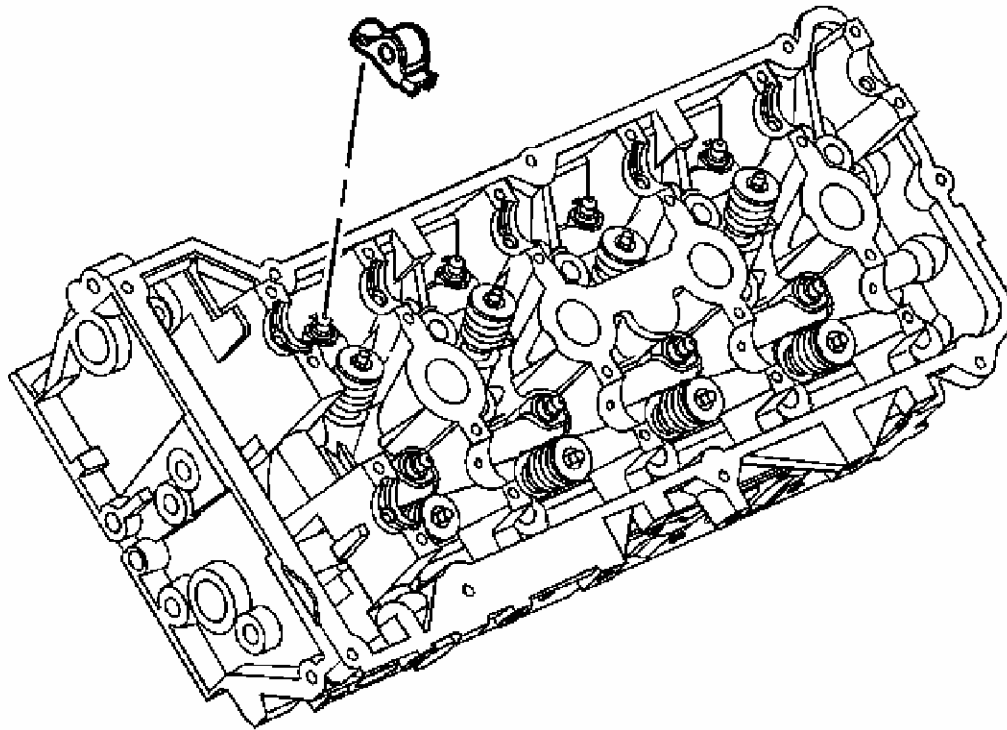


Fig. 314: Identifying Camshaft Followers
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: If the followers are being reused, arrange them so that they may be put back in their original locations.

2. Remove the camshaft followers.
3. Clean and inspect the rocker arms. Refer to **Valve Rocker Arms Cleaning and Inspection** .

INSTALLATION PROCEDURE

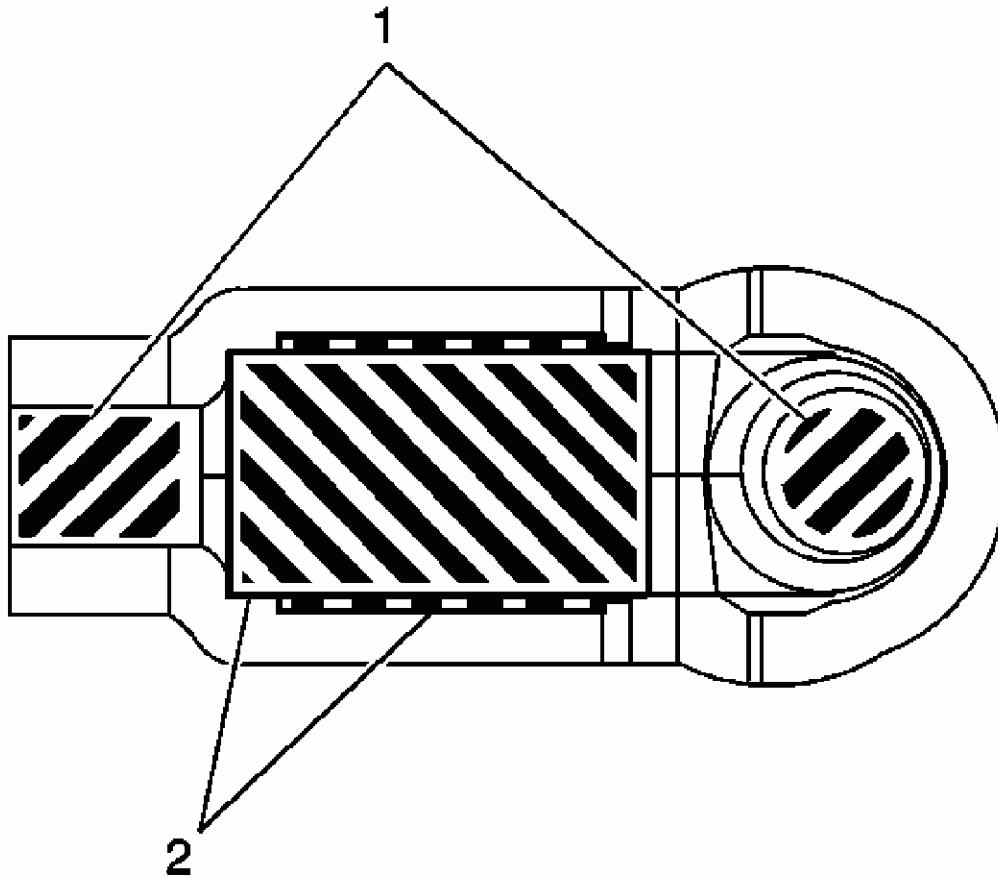


Fig. 315: Identifying Roller Pivot Pocket (2) & Valve Slot Areas (1) Of Camshaft Followers

Courtesy of GENERAL MOTORS CORP.

1. Apply a liberal amount of lubricant to the roller pivot pocket (2) and valve slot areas (1) of the camshaft followers. Refer to **Sealers, Adhesives and Lubricants** .

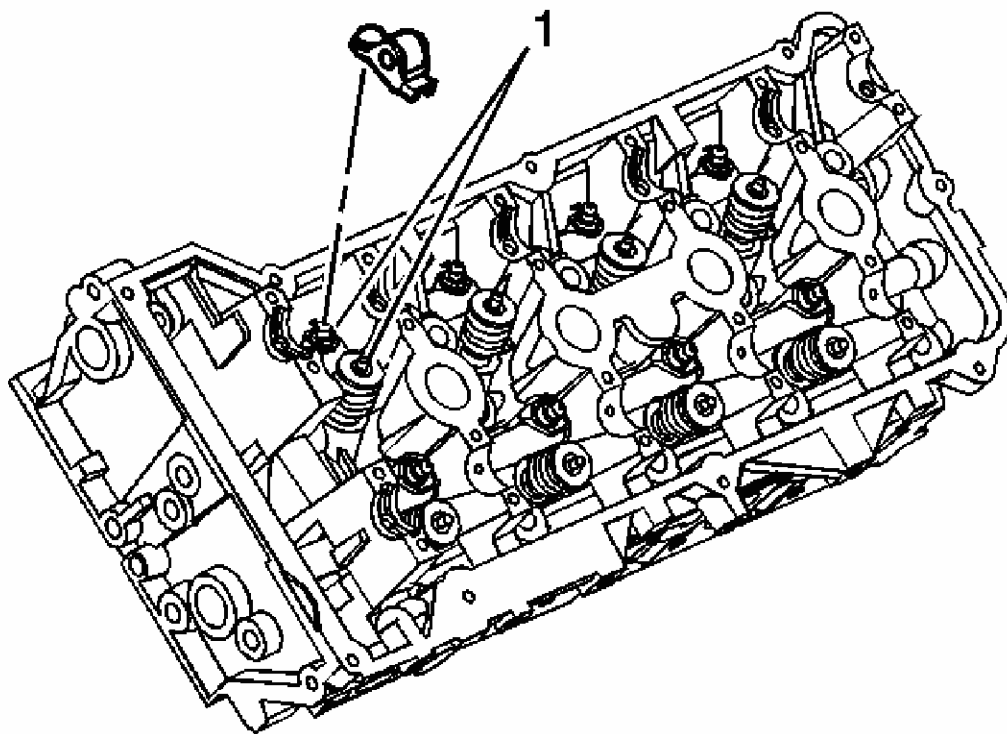


Fig. 316: Identifying the Stationary Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The follower must be positioned squarely on the valve tip so that the full width of the roller will completely contact the camshaft lobe. If the followers are being reused you must put them back in their original location.

2. Place the camshaft followers in position on the valve tip (1) and the SHLA (1). The rounded head of the follower goes on the SHLA, while the flat end goes on the valve tip.
3. Install the left camshafts. Refer to **Camshaft Replacement - Left Side**.

VALVE ROCKER ARM REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

1. Remove the right camshafts. Refer to **Camshaft Replacement - Right Side**.

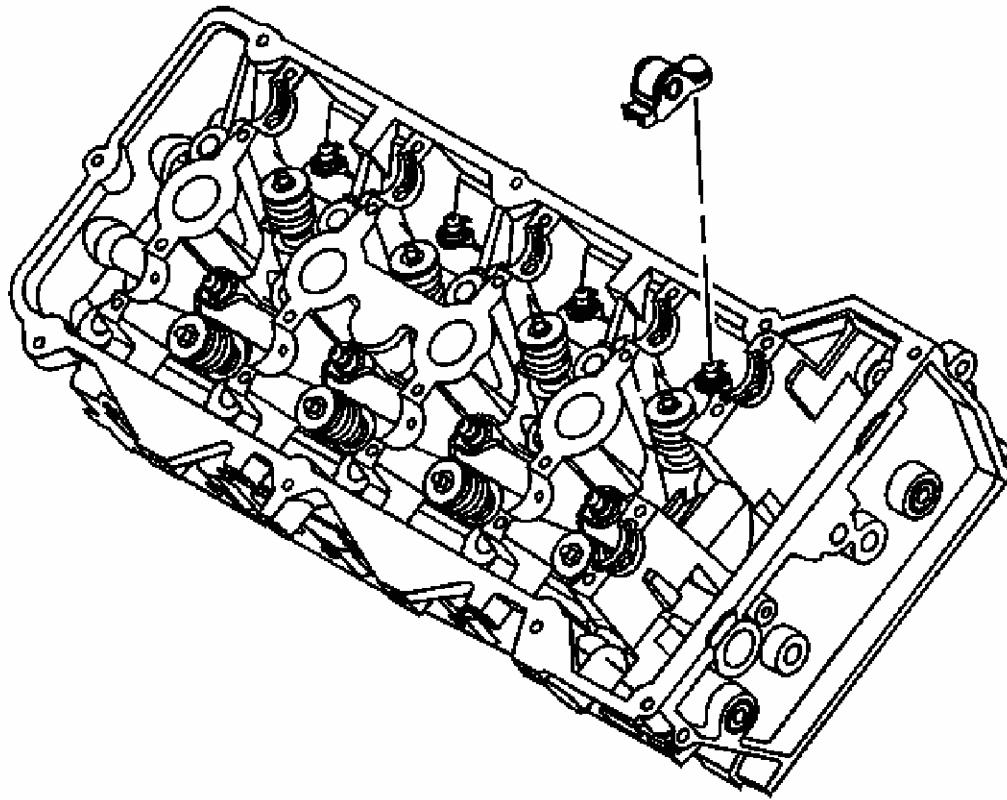


Fig. 317: View of Camshaft Followers
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: If the followers are being reused, arrange them so that they may be put back in their original locations.

2. Remove the camshaft followers.
3. Clean and inspect the rocker arms. Refer to **Valve Rocker Arms Cleaning and Inspection** .

INSTALLATION PROCEDURE

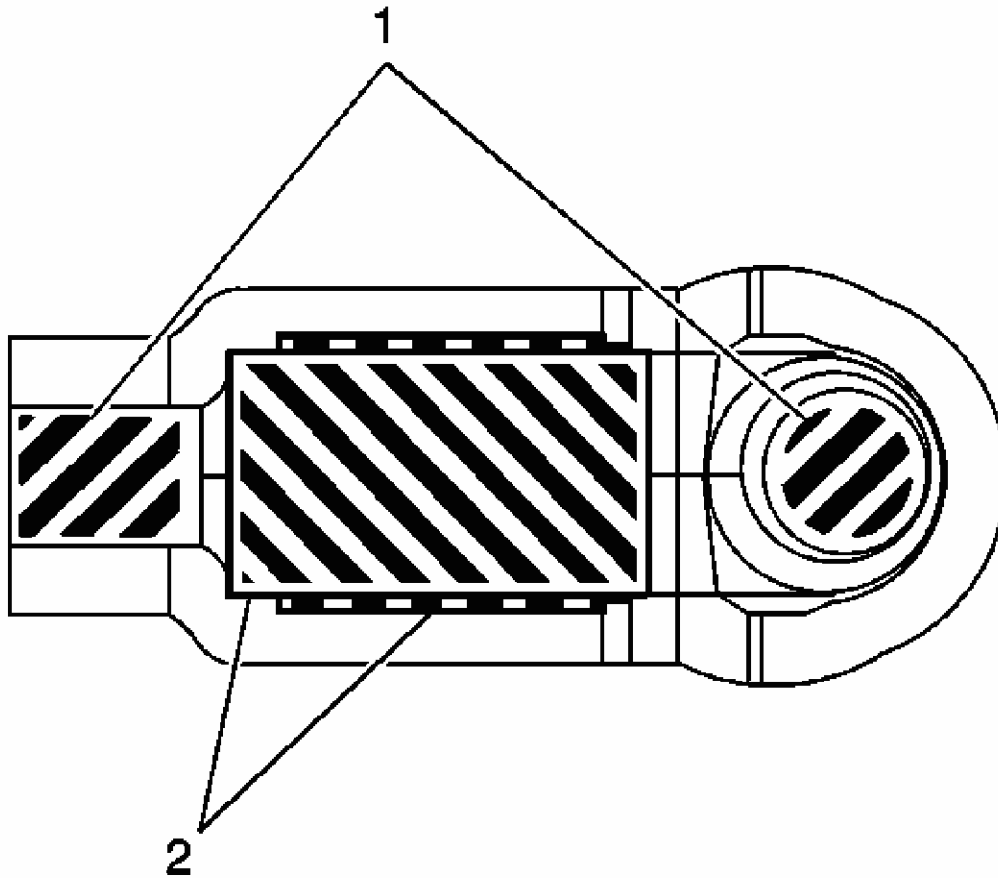


Fig. 318: Identifying Roller Pivot Pocket (2) & Valve Slot Areas (1) Of Camshaft Followers

Courtesy of GENERAL MOTORS CORP.

1. Apply a liberal amount of lubricant to the roller pivot pocket (2) and valve slot areas (1) of the camshaft followers. Refer to **Sealers, Adhesives and Lubricants** .

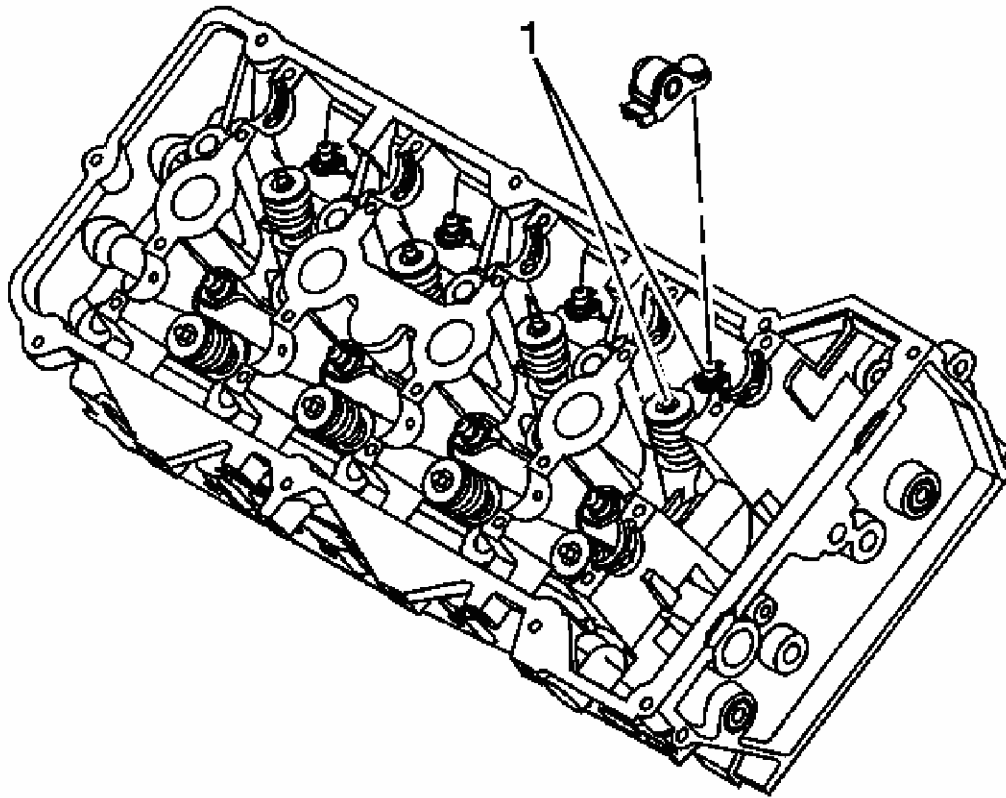


Fig. 319: Identifying Stationary Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The follower must be positioned squarely on the valve tip so that the full width of the roller will completely contact the camshaft lobe. If the followers are being reused you must put them back in their original location.

2. Place the camshaft followers in position on the valve tip (1) and the SHLA (1). The rounded head of the follower goes on the SHLA, while the flat end goes on the valve tip.
3. Install the right camshafts. Refer to **Camshaft Replacement - Right Side**.

VALVE LIFTER REPLACEMENT - LEFT SIDE

REMOVAL PROCEDURE

1. Remove the left valve rocker arms. Refer to **Valve Rocker Arm Replacement - Left Side**.

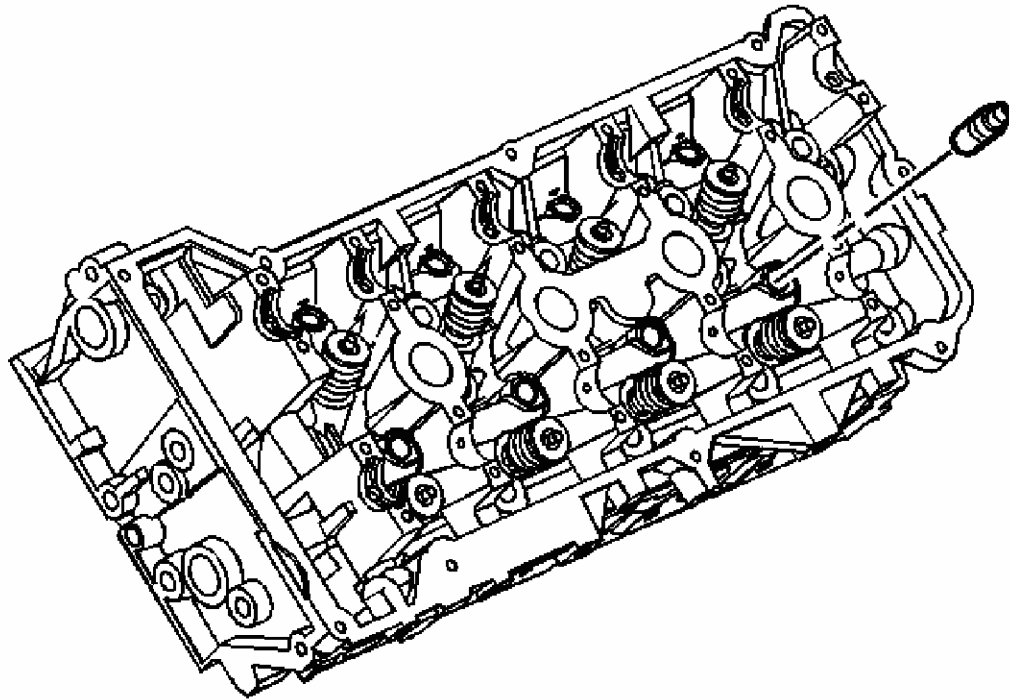


Fig. 320: Locating Left Stationary Hydraulic Lash Adjusters (SHLA)
Courtesy of GENERAL MOTORS CORP.

2. Remove the stationary hydraulic lash adjusters (SHLA) from the bores.
3. Clean and inspect the valve lifters. Refer to **Valve Lifters Cleaning and Inspection** .

INSTALLATION PROCEDURE

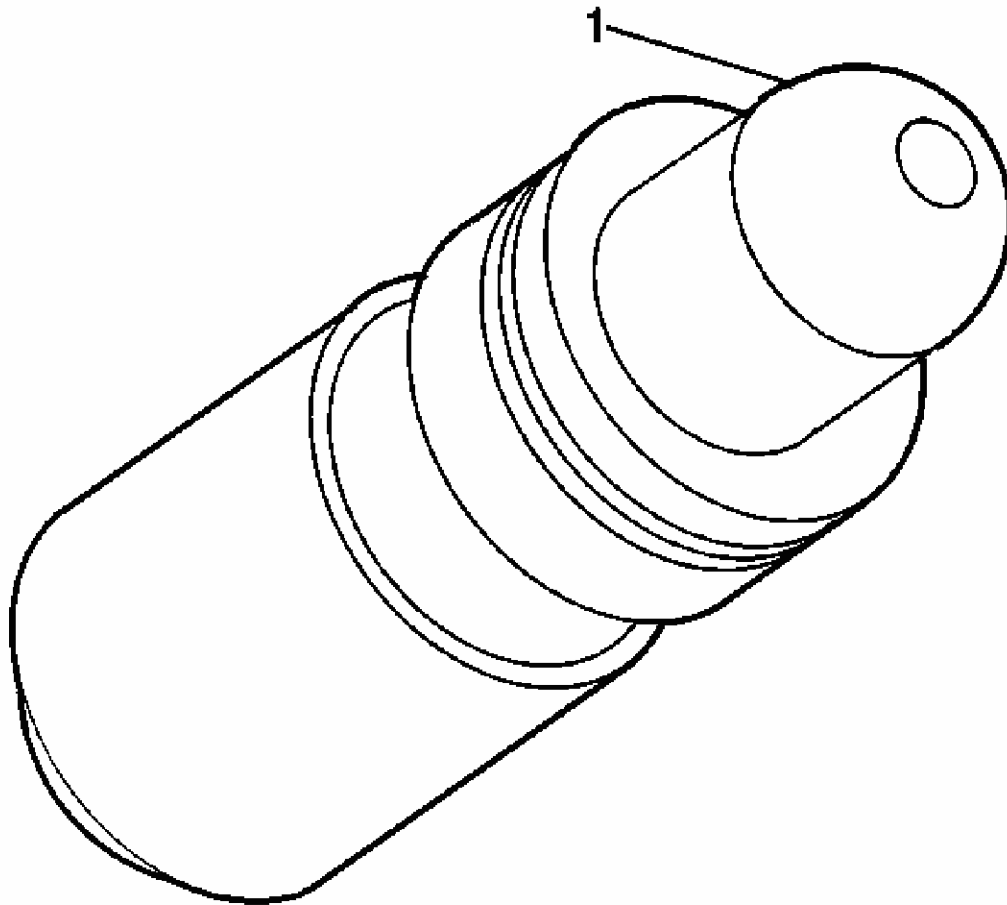


Fig. 321: View Of Valve Lifter
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not stroke/cycle the stationary hydraulic lash adjuster plunger without oil in the lower pressure chamber.

1. Fill the stationary hydraulic lash adjuster (SHLA) with clean engine oil. Refer to **Sealers, Adhesives and Lubricants** . Take precautions to prevent scratching the pivot sphere area (1) of the SHLA.

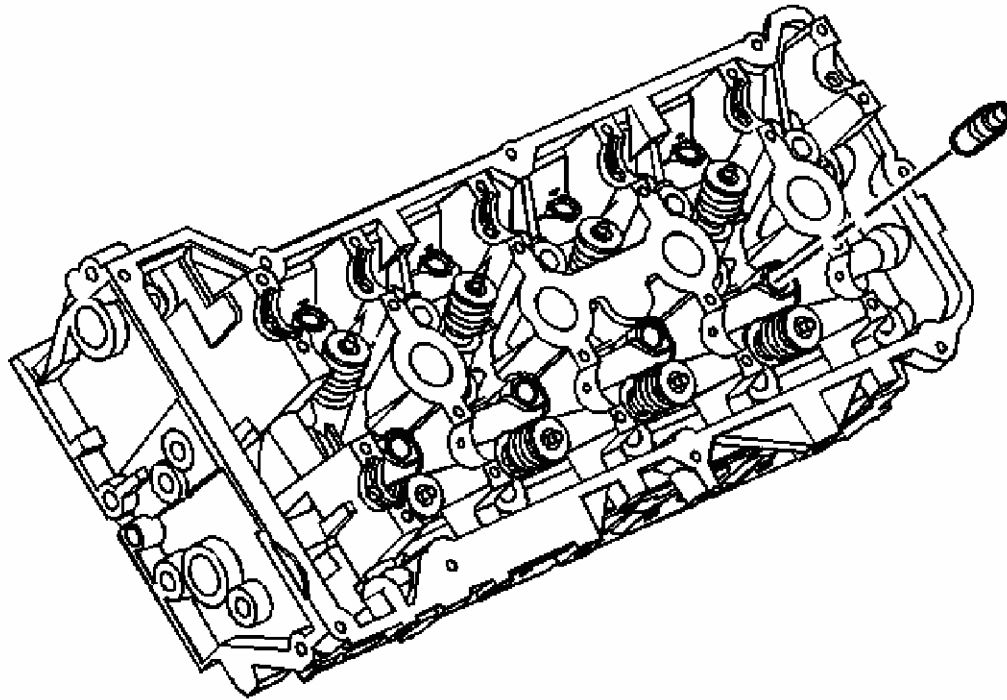


Fig. 322: Locating Left Stationary Hydraulic Lash Adjusters (SHLA)
Courtesy of GENERAL MOTORS CORP.

2. Install the new SHLA's into the bores.
3. Install the left valve rocker arms. Refer to **Valve Rocker Arm Replacement - Left Side**.

VALVE LIFTER REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

1. Remove the right valve rocker arms. Refer to **Valve Rocker Arm Replacement - Right Side**.

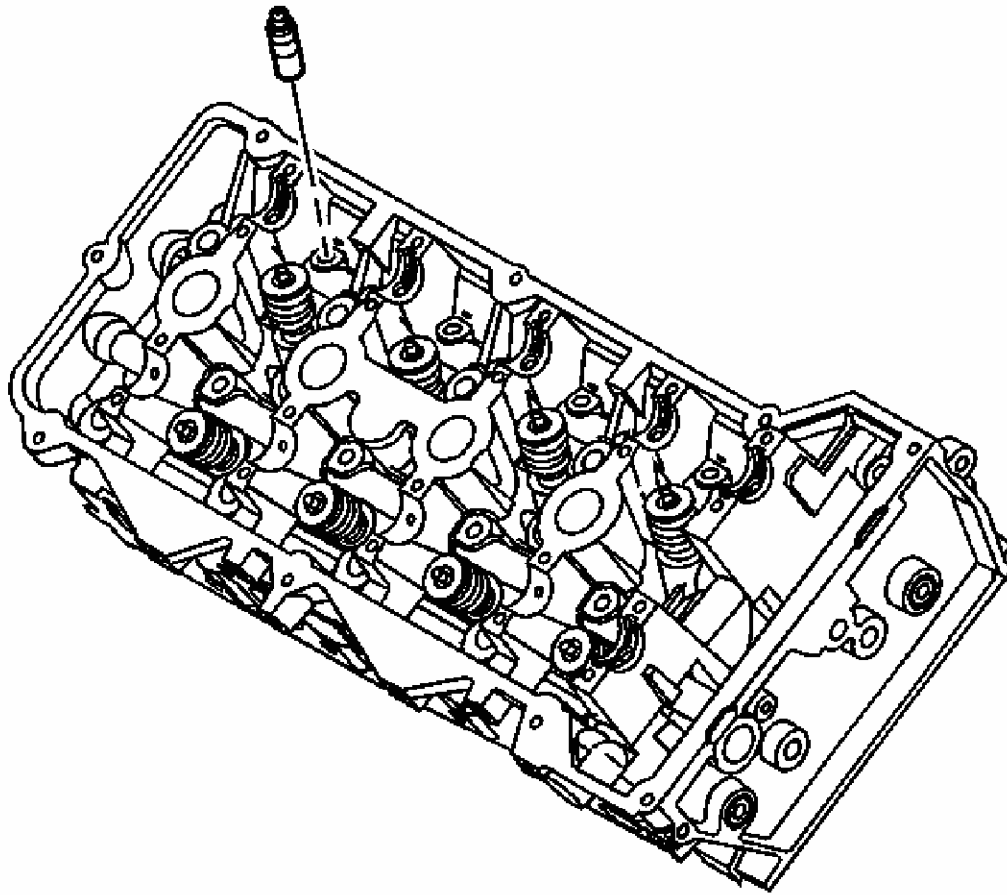


Fig. 323: View Of Stationary Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS CORP.

2. Remove the stationary hydraulic lash adjusters (SHLA) from the bores.
3. Clean and inspect the valve lifters. Refer to **Valve Lifters Cleaning and Inspection** .

INSTALLATION PROCEDURE

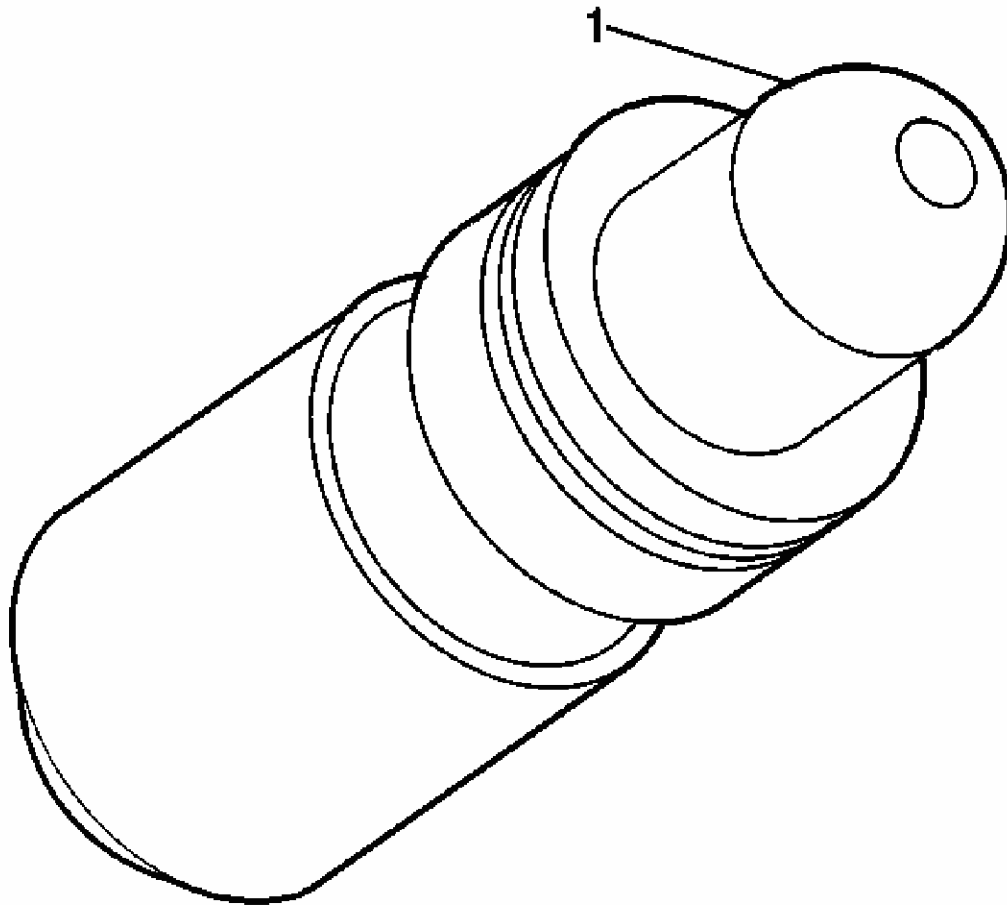


Fig. 324: View Of Valve Lifter
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not stroke/cycle the stationary hydraulic lash adjuster plunger without oil in the lower pressure chamber.

1. Fill the stationary hydraulic lash adjuster (SHLA) with clean engine oil. Refer to **Sealers, Adhesives and Lubricants** . Take precautions to prevent scratching the pivot sphere area (1) of the SHLA.

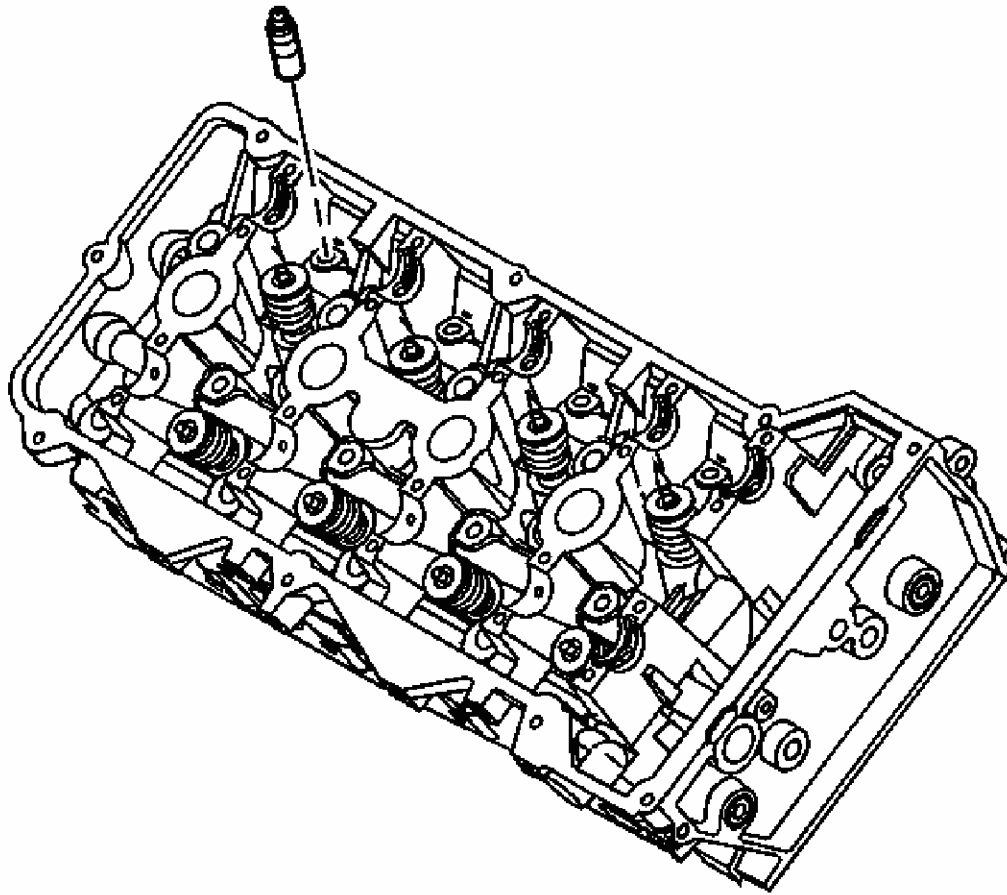


Fig. 325: View of Stationary Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS CORP.

2. Install the new SHLA's into the bores.
3. Install the right valve rocker arms. Refer to **Valve Rocker Arm Replacement - Right Side**.

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT - LEFT SIDE

TOOLS REQUIRED

- **J 38820** Valve Stem Seal Remover and Installer. See **Special Tools** .
- **J 39313** Spark Plug Port Adapter. See **Special Tools** .
- **J 43059** On-Vehicle Valve Retainer Remover/Installer

- **J 44211** Valve Spring Compressor. See **Special Tools** .
- **J 44214** Flywheel Holder. See **Special Tools** .

REMOVAL PROCEDURE

1. Remove the left camshafts. Refer to **Camshaft Replacement - Left Side**.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

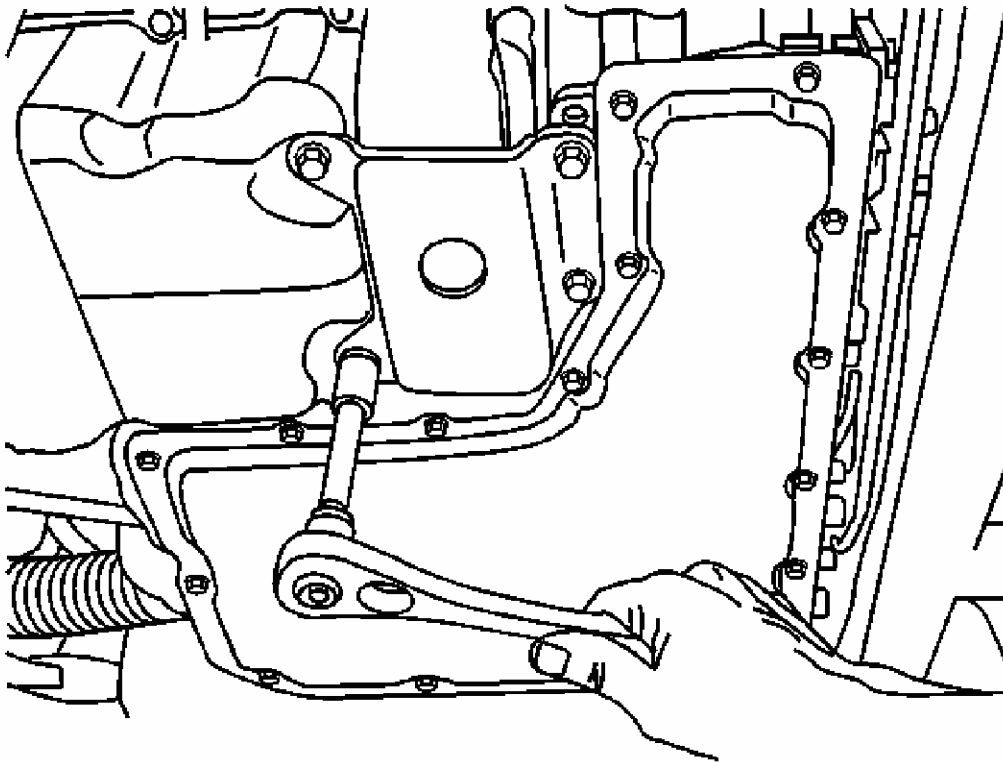


Fig. 326: View Of Brace Between The Engine Oil Pan And The Transaxle Case
Courtesy of GENERAL MOTORS CORP.

3. Remove the brace between the engine oil pan and the transaxle case.
4. Remove the torque converter cover. Refer to **Torque Converter Cover Replacement** .

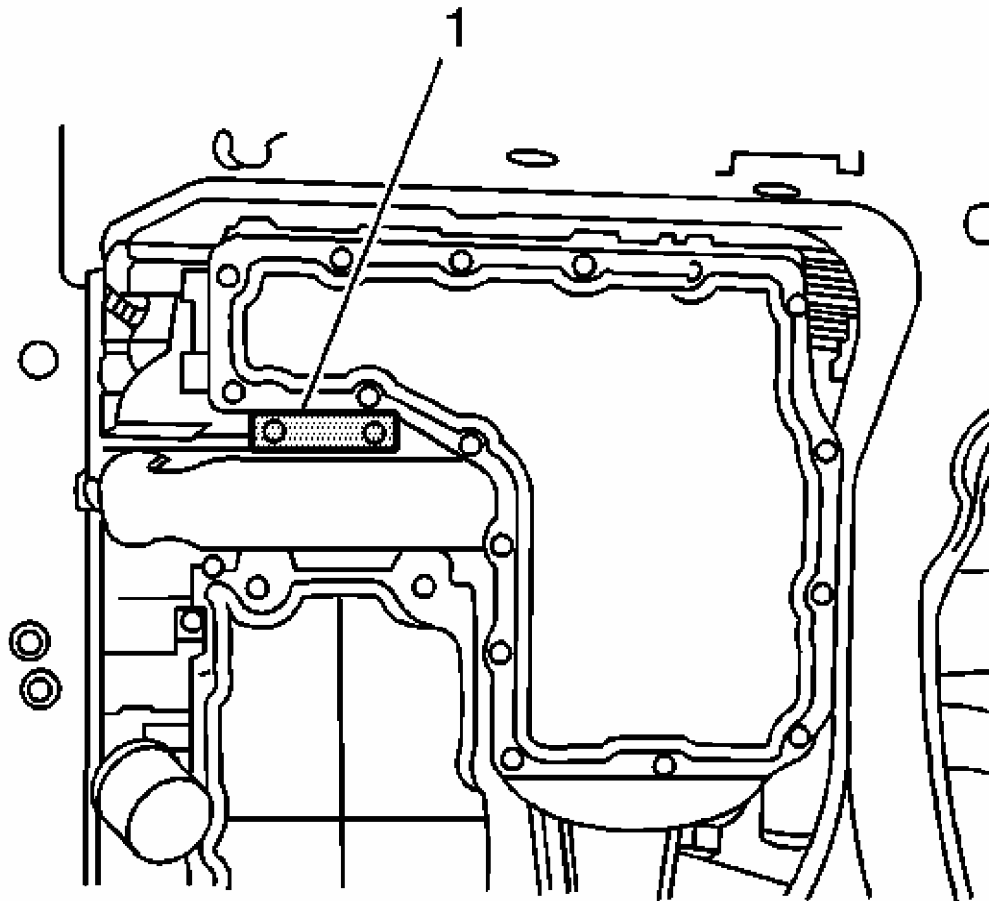


Fig. 327: Locating Flywheel Holder J 44214
Courtesy of GENERAL MOTORS CORP.

5. Install the J 44214 (1). See Special Tools .
6. Lower the vehicle.

NOTE: Clean the spark plug recess area before removing the spark plug. Failure to do so could result in engine damage because of dirt or foreign material entering the cylinder head or by the contamination of the cylinder head threads. The contaminated threads may prevent the proper seating of the new plug. Use a thread chaser to clean the threads of any contamination.

7. Remove the spark plug from the cylinder being worked on.

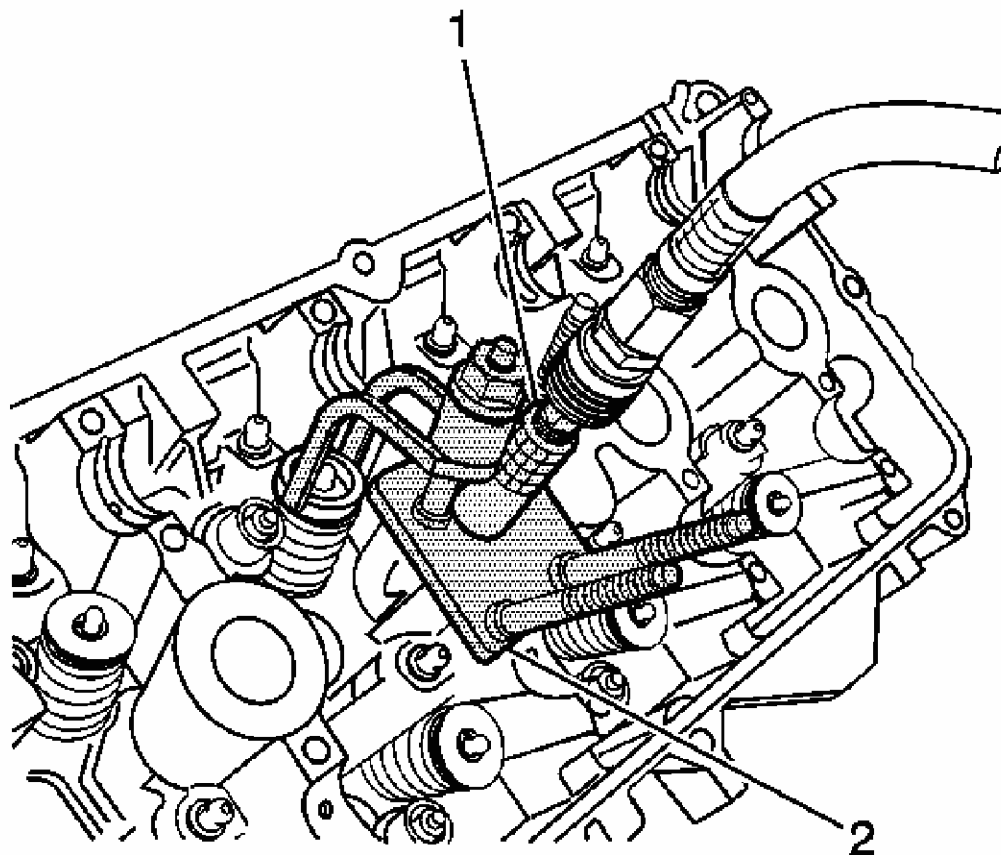


Fig. 328: View Of Base Plate Installed Over The Spark Plug Hole For Changing Valve Stem Seal

Courtesy of GENERAL MOTORS CORP.

8. Install the base plate of the **J 44211** (2) over the spark plug hole of the cylinder to be serviced. See **Special Tools** .
9. Install the **J 39313** (1) in the spark plug hole. See **Special Tools** .
10. Apply constant air pressure to the **J 39313** (1) in order to keep the valve closed. See **Special Tools** .
11. Install the arm and swivel nut of the **J 44211** (2) over the stud corresponding to the valve to be serviced. See **Special Tools** .

CAUTION: Refer to Compressed Valve Spring Caution .

12. Tighten the swivel nut of the **J 44211** (2) down only enough to allow access for removal

of the valve locks. See **Special Tools** .

13. Remove the valve locks. A magnet is the most suitable tool for this activity.
14. Loosen the swivel nut of the **J 44211** (2) and swing the arm away from the valve spring retainer. See **Special Tools** .
15. Remove the valve spring retainer and valve spring.

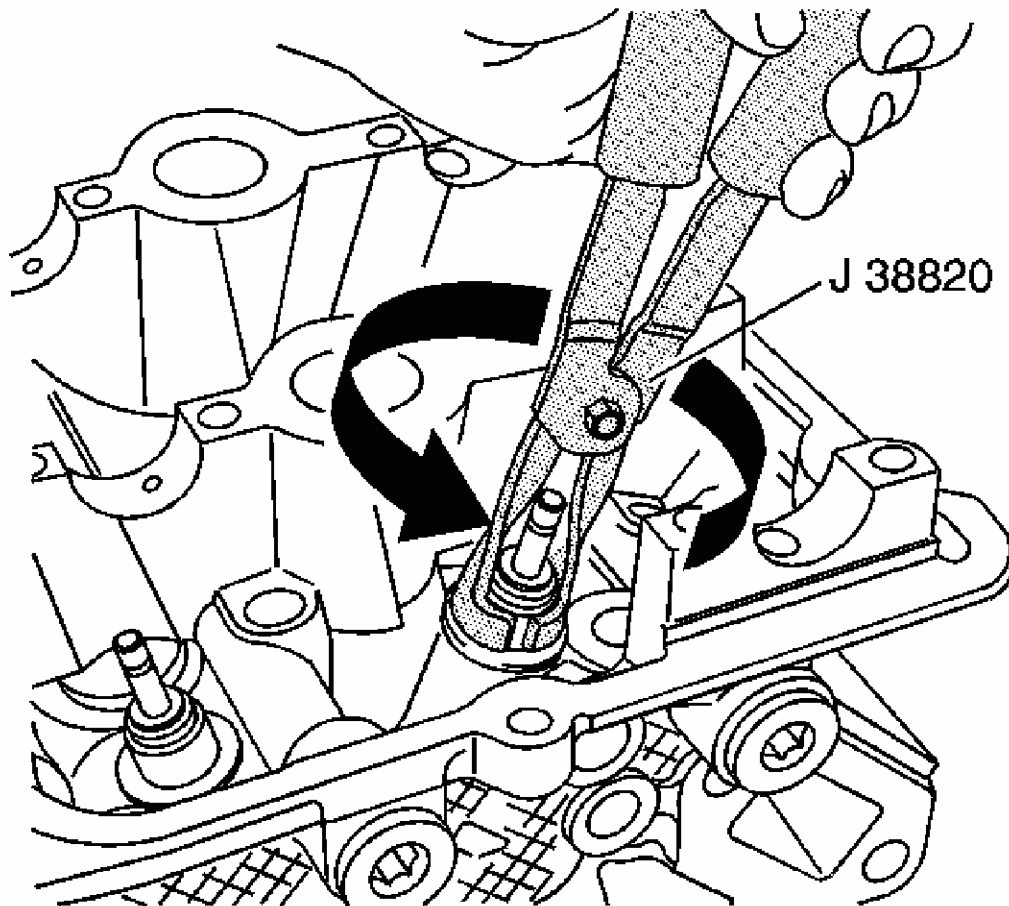


Fig. 329: Using J 38820 To Replace Valve Seal
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The valve stem seal should not be removed unless replacement is required.

16. Use the **J 38820** in order to grip the seal. See **Special Tools** . Remove the seal by exerting a twisting, pulling motion. Discard the old valve stem seal.
17. Inspect and measure the valve spring. Refer to **Valve Spring Inspection and**

Measurement .

INSTALLATION PROCEDURE

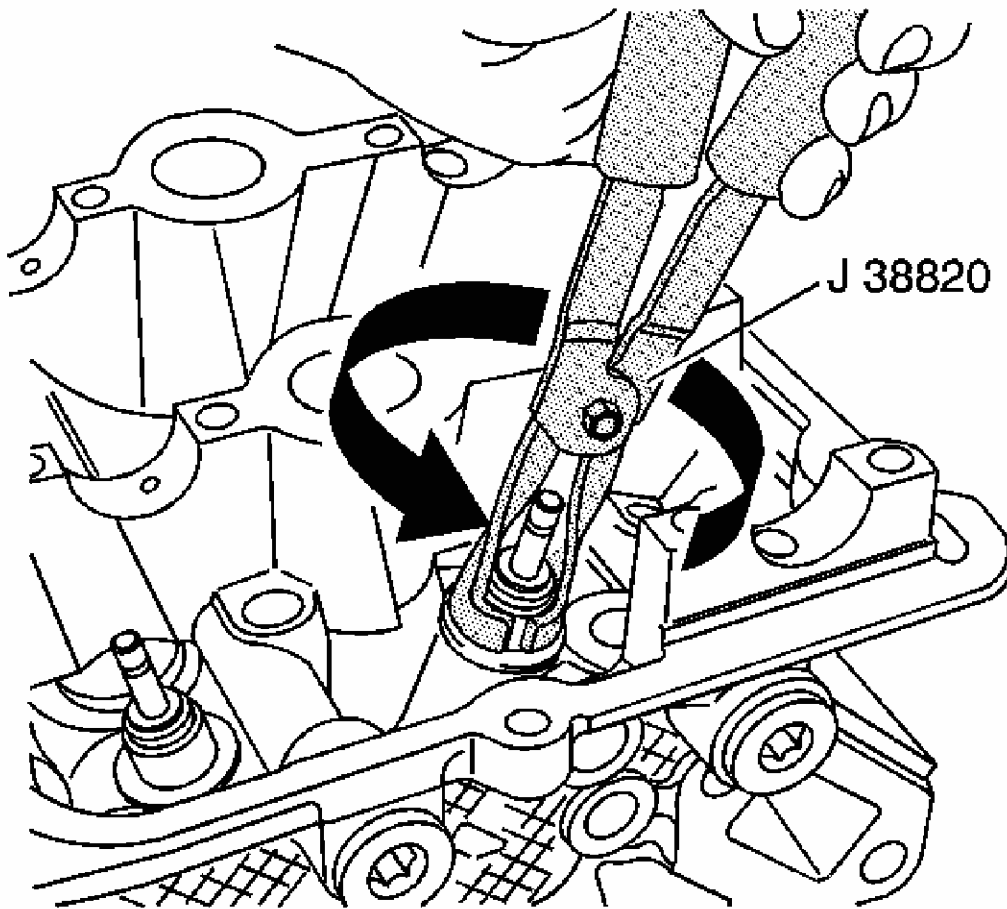


Fig. 330: Using J 38820 To Replace Valve Seal
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the valve stem and the inner diameter of the new seal with clean engine oil.

IMPORTANT: Install a seal protector over the valve stem prior to installing the valve stem seal.

2. Using a twisting pushing motion install the NEW valve stem seal using the **J 38820** . See **Special Tools** .
3. Install the valve spring retainer and valve spring.

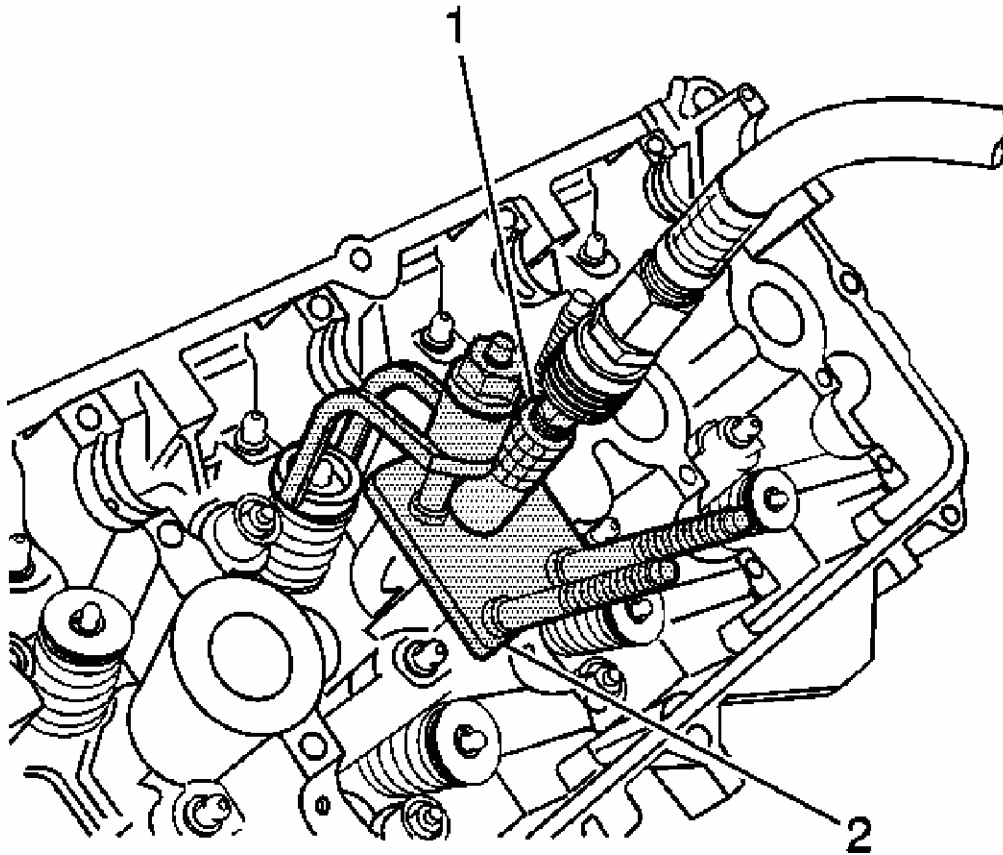


Fig. 331: View Of Base Plate Installed Over The Spark Plug Hole For Changing Valve Stem Seal

Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Compressed Valve Spring Caution .

4. Swing the arm over the valve spring retainer and tighten the swivel nut of the **J 44211** (2) down only enough to allow access for installation of the valve locks. See **Special Tools** .
5. Position the valve locks to the valve stem retainer groove using the **J 43059** .
6. Remove the swivel nut and arm of the **J 44211** (2). See **Special Tools** .
7. Install the arm and swivel nut of the **J 44211** (2) over the stud of any other valves being serviced and repeat removal steps 12 through 17 and installation steps 1 through 7. See **Special Tools** .
8. Relieve the air pressure to the cylinder being serviced.

9. Remove the **J 39313** (1) from the spark plug hole. See **Special Tools** .
10. Remove the base plate of the **J 44211** (2). See **Special Tools** .
11. Install the spark plug. Refer to **Spark Plug Replacement** .
12. Repeat removal steps 7 through 17 and installation steps 1 through 11 on any other cylinders being serviced.
13. Install the left camshafts. Refer to **Camshaft Replacement - Left Side**.
14. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

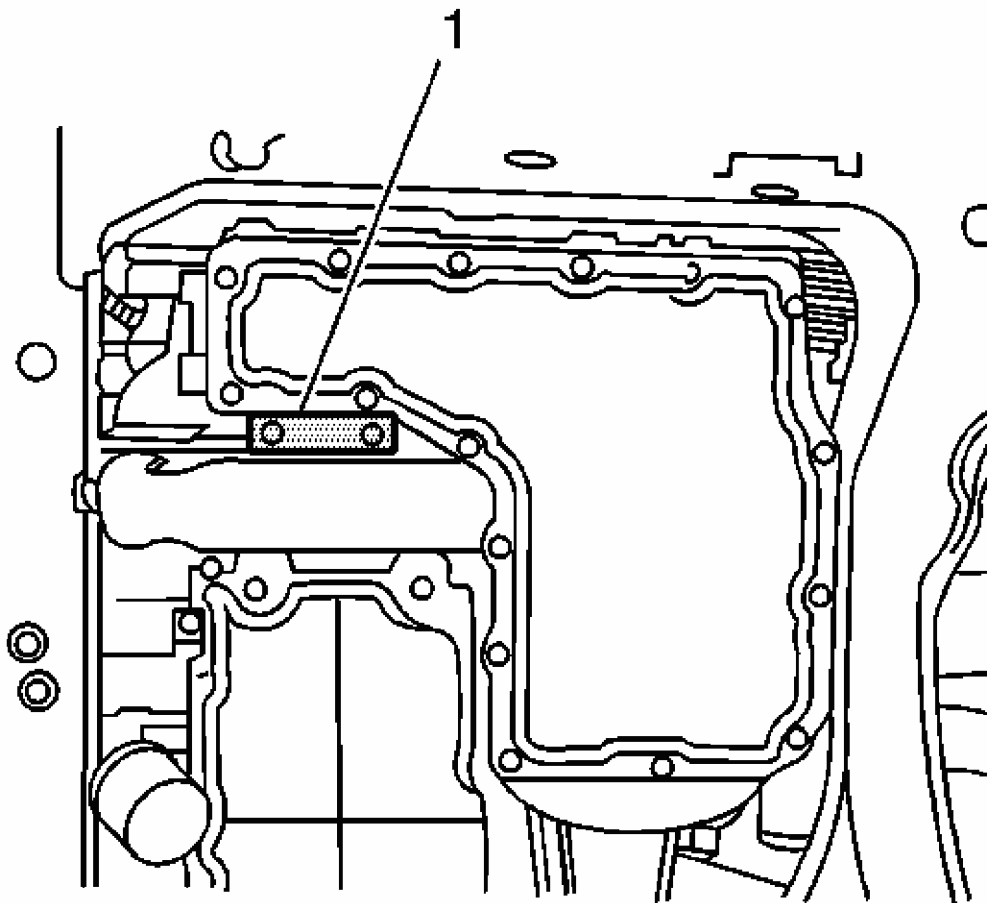


Fig. 332: Locating Flywheel Holder J 44214
Courtesy of GENERAL MOTORS CORP.

15. Remove the **J 44214** (1). See **Special Tools** .
16. Install the torque converter cover. Refer to **Torque Converter Cover Replacement** .

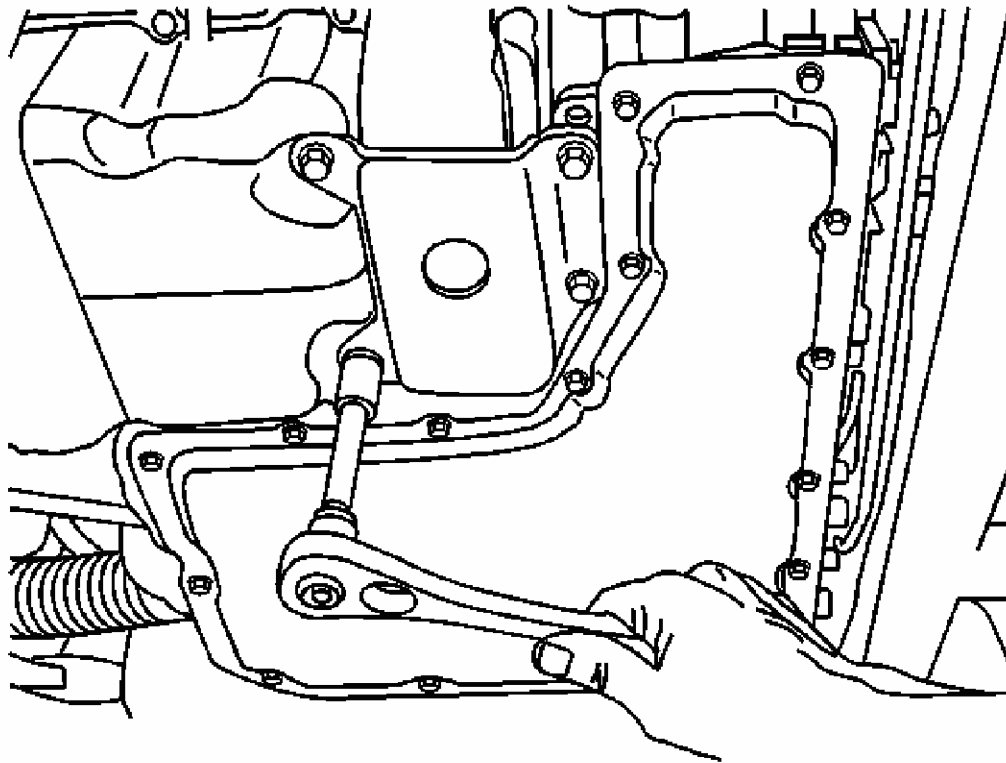


Fig. 333: View Of Brace Between The Engine Oil Pan And The Transaxle Case
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE .

17. Install the oil pan to transaxle brace.

Tighten: Tighten the oil pan to transaxle brace bolts to 50 N.m (37 lb ft).

18. Lower the vehicle.

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT - RIGHT SIDE

TOOLS REQUIRED

- **J 38820** Valve Stem Seal Remover and Installer. See Special Tools .
- **J 39313** Spark Plug Port Adapter. See Special Tools .
- **J 43059** Valve Retainer Remover/Installer

- **J 44211** On-Vehicle Valve Spring Compressor. See **Special Tools** .
- **J 44214** Flywheel Holder. See **Special Tools** .

REMOVAL PROCEDURE

1. Remove the right camshafts. Refer to **Camshaft Replacement - Right Side**.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

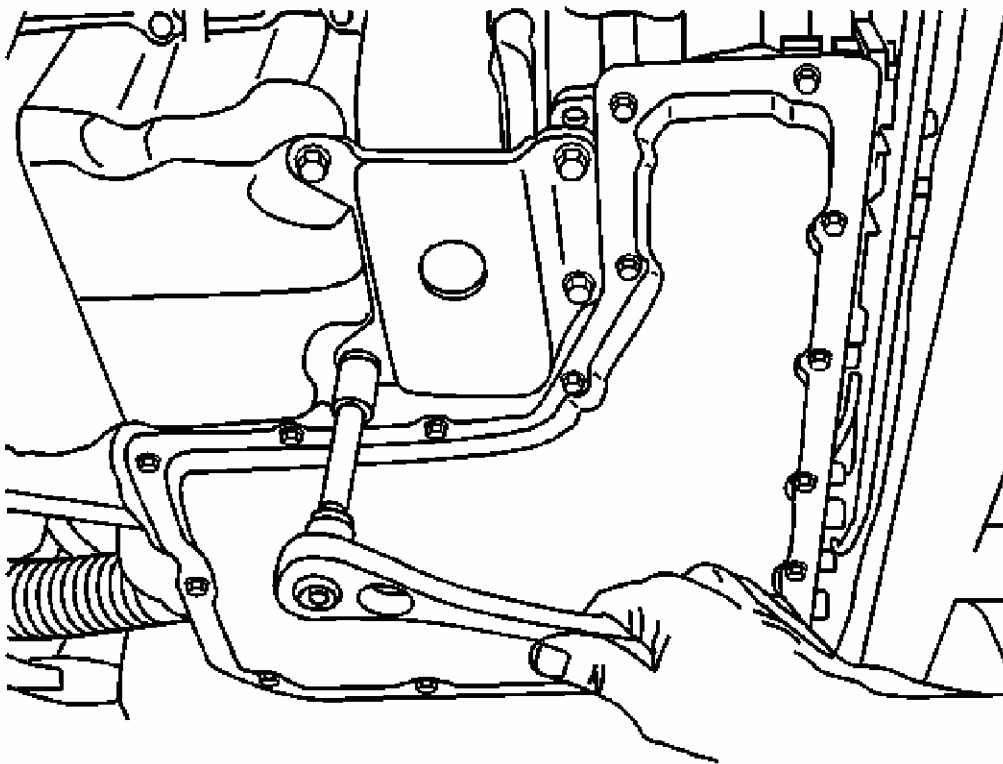


Fig. 334: View Of Brace Between The Engine Oil Pan And The Transaxle Case
Courtesy of GENERAL MOTORS CORP.

3. Remove the brace between the engine oil pan and the transaxle case.
4. Remove the torque converter cover. Refer to **Torque Converter Cover Replacement** .

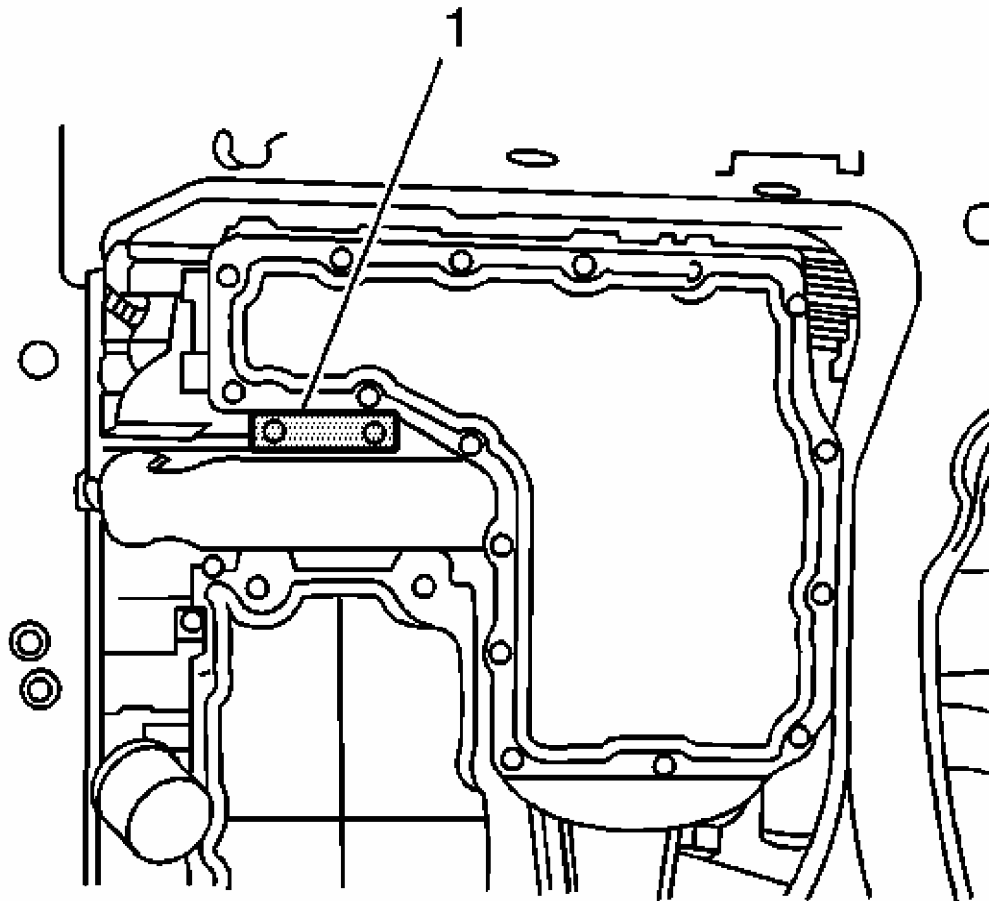


Fig. 335: Locating Flywheel Holder J 44214
Courtesy of GENERAL MOTORS CORP.

5. Install the J 44214 (1). See Special Tools .
6. Lower the vehicle.

NOTE: Clean the spark plug recess area before removing the spark plug. Failure to do so could result in engine damage because of dirt or foreign material entering the cylinder head or by the contamination of the cylinder head threads. The contaminated threads may prevent the proper seating of the new plug. Use a thread chaser to clean the threads of any contamination.

7. Remove the spark plug from the cylinder being worked on.

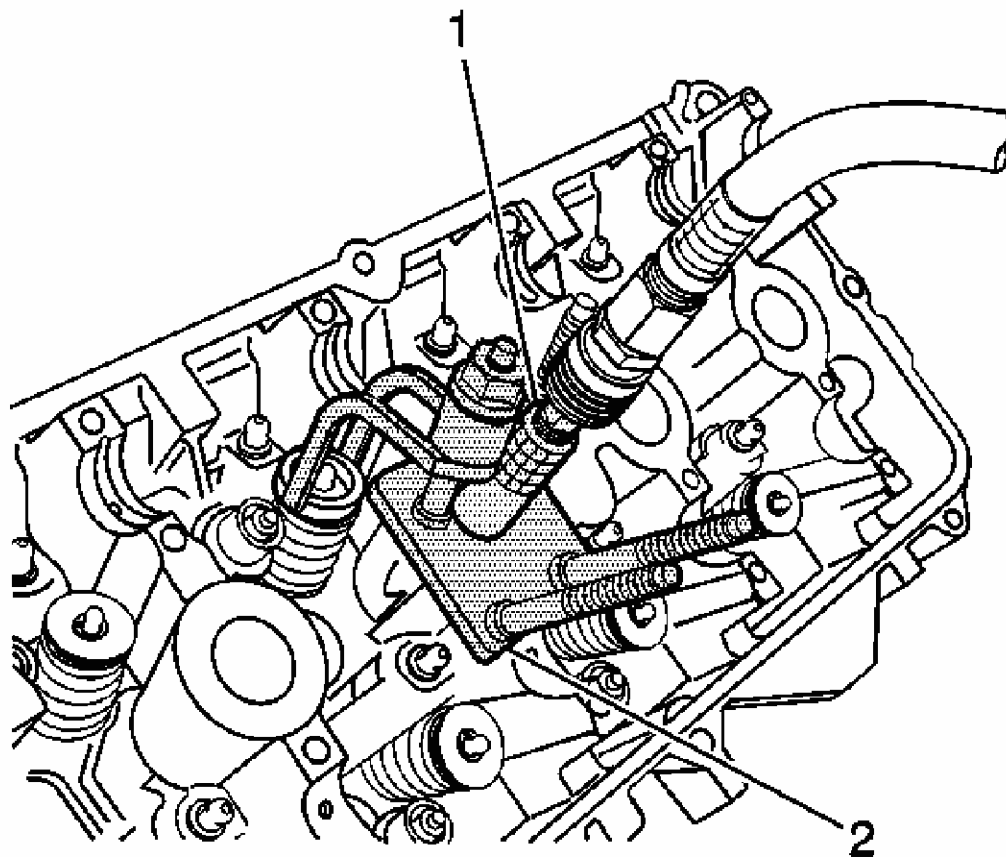


Fig. 336: View Of Base Plate Installed Over The Spark Plug Hole For Changing Valve Stem Seal

Courtesy of GENERAL MOTORS CORP.

8. Install the base plate of the **J 44211** (2) over the spark plug hole of the cylinder to be serviced. See **Special Tools** .
9. Install the **J 39313** (1) in the spark plug hole. See **Special Tools** .
10. Apply constant air pressure to the **J 39313** (1) in order to keep the valve closed. See **Special Tools** .
11. Install the arm and swivel nut of the **J 44211** (2) over the stud corresponding to the valve to be serviced. See **Special Tools** .

CAUTION: Refer to Compressed Valve Spring Caution .

12. Tighten the swivel nut of the **J 44211** (2) down only enough to allow access for removal

of the valve locks. See **Special Tools** .

13. Remove the valve locks. A magnet is the most suitable tool for this activity.
14. Loosen the swivel nut of the **J 44211** (2) and swing the arm away from the valve spring retainer. See **Special Tools** .
15. Remove the valve spring retainer and valve spring.

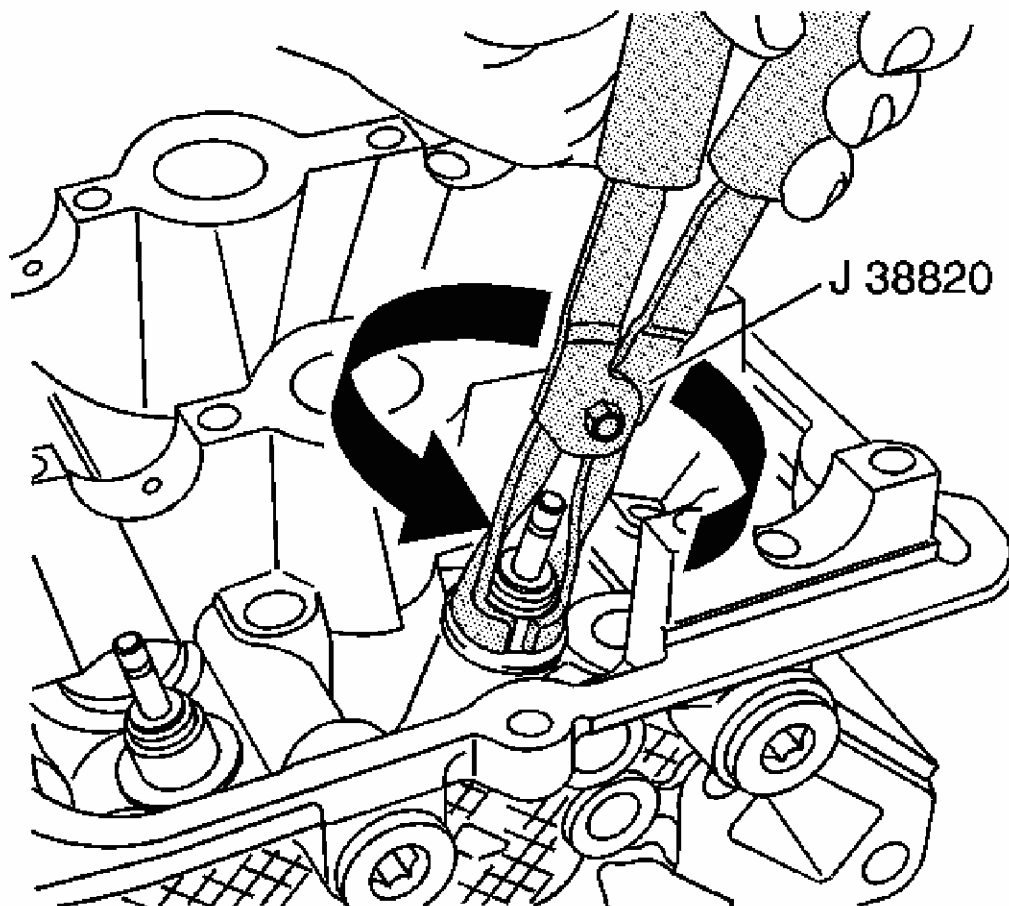


Fig. 337: Using J 38820 To Replace Valve Seal
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The valve stem seal should not be removed unless replacement is required.

16. Use the **J 38820** in order to grip the seal. See **Special Tools** . Remove the seal by exerting a twisting, pulling motion. Discard the old valve stem seal.
17. Inspect and measure the valve spring. Refer to **Valve Spring Inspection and**

Measurement .

INSTALLATION PROCEDURE

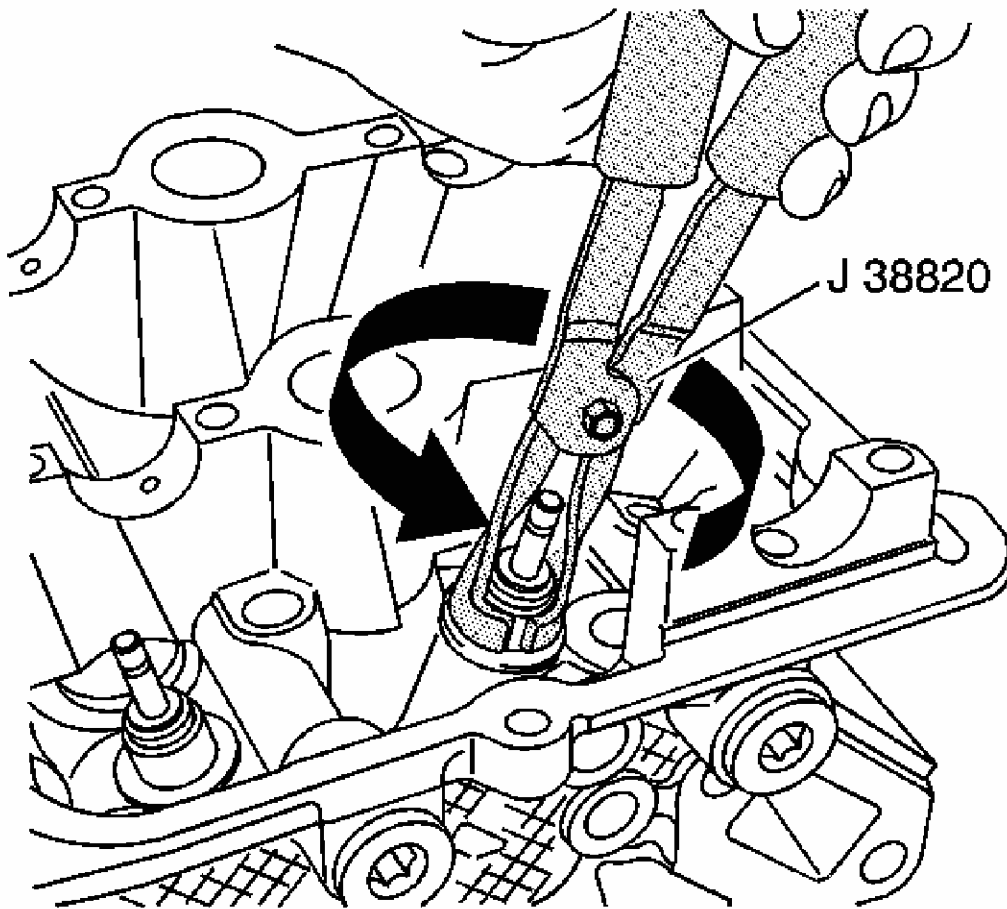


Fig. 338: Using J 38820 To Replace Valve Seal
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the valve stem and the inner diameter of the new seal with clean engine oil.

IMPORTANT: Install a seal protector over the valve stem prior to installing the valve stem seal.

2. Using a twisting pushing motion install the NEW valve stem seal using the **J 38820** . See **Special Tools** .
3. Install the valve spring retainer and valve spring.

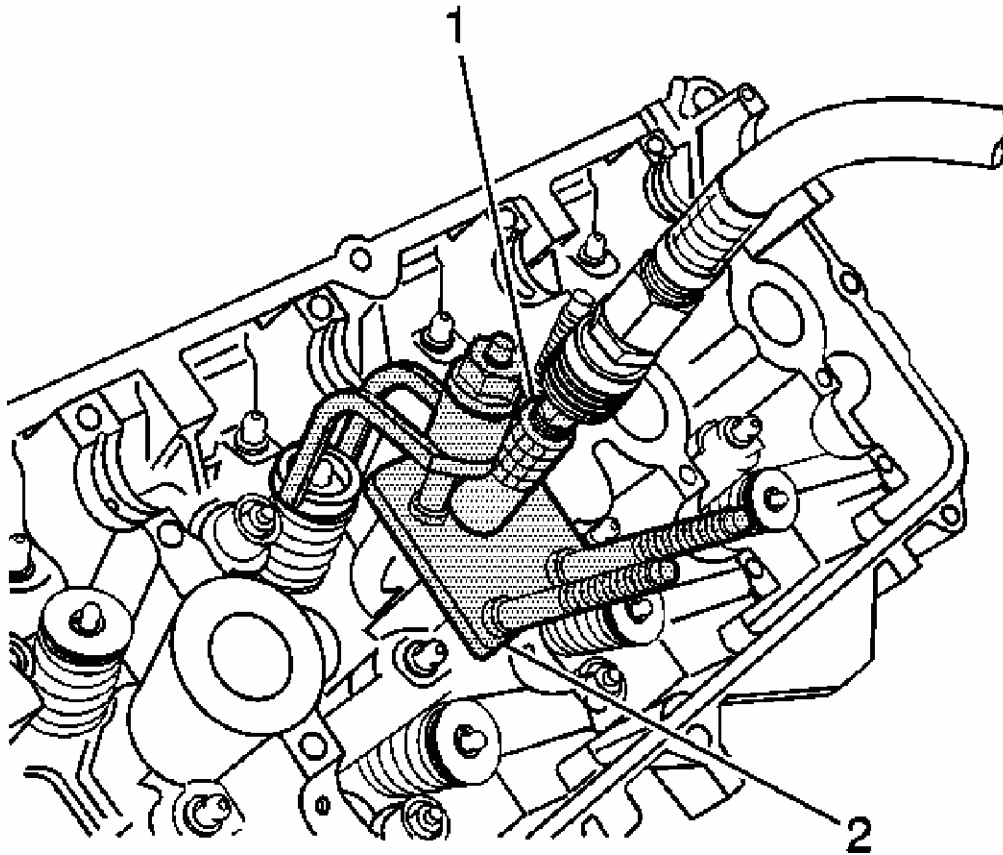


Fig. 339: View Of Base Plate Installed Over The Spark Plug Hole For Changing Valve Stem Seal

Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Compressed Valve Spring Caution .

4. Swing the arm over the valve spring retainer and tighten the swivel nut of the **J 44211** (2) down only enough to allow access for installation of the valve locks. See **Special Tools** .
5. Position the valve locks to the valve stem retainer groove using the **J 43059** .
6. Remove the swivel nut and arm of the **J 44211** (2). See **Special Tools** .
7. Install the arm and swivel nut of the **J 44211** (2) over the stud of any other valves being serviced and repeat removal steps 12 through 17 and installation steps 1 through 7. See **Special Tools** .
8. Relieve the air pressure to the cylinder being serviced.

9. Remove the **J 39313** (1) from the spark plug hole. See **Special Tools** .
10. Remove the base plate of the **J 44211** (2). See **Special Tools** .
11. Install the spark plug. Refer to **Spark Plug Replacement** .
12. Repeat removal steps 7 through 17 and installation steps 1 through 11 on any other cylinders being serviced.
13. Install the right camshafts. Refer to **Camshaft Replacement - Right Side**.
14. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

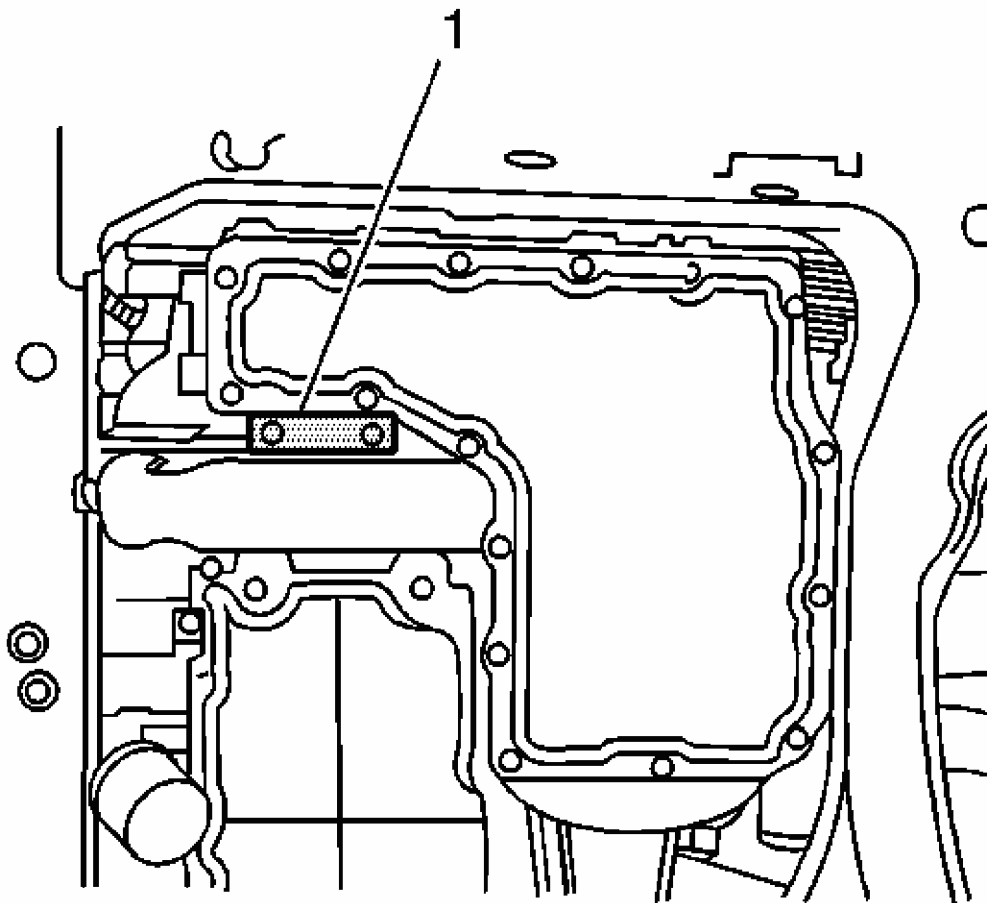


Fig. 340: Locating Flywheel Holder J 44214
Courtesy of GENERAL MOTORS CORP.

15. Remove the **J 44214** (1). See **Special Tools** .
16. Install the torque converter cover. Refer to **Torque Converter Cover Replacement** .

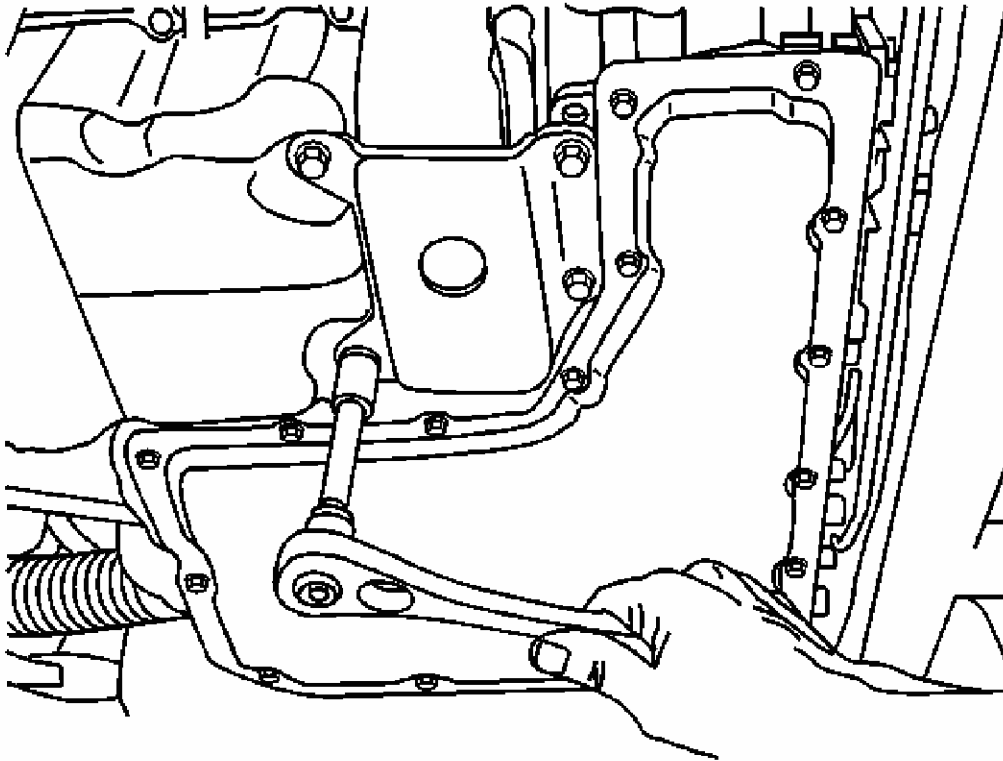


Fig. 341: View Of Brace Between The Engine Oil Pan And The Transaxle Case
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE .

17. Install the oil pan to transaxle brace.

Tighten: Tighten the oil pan to transaxle brace bolts to 50 N.m (37 lb ft).

18. Lower the vehicle.

CYLINDER HEAD REPLACEMENT - LEFT SIDE

TOOLS REQUIRED

- **J 28410** Gasket Remover. See Special Tools .
- **J 45059** Angle Meter

REMOVAL PROCEDURE

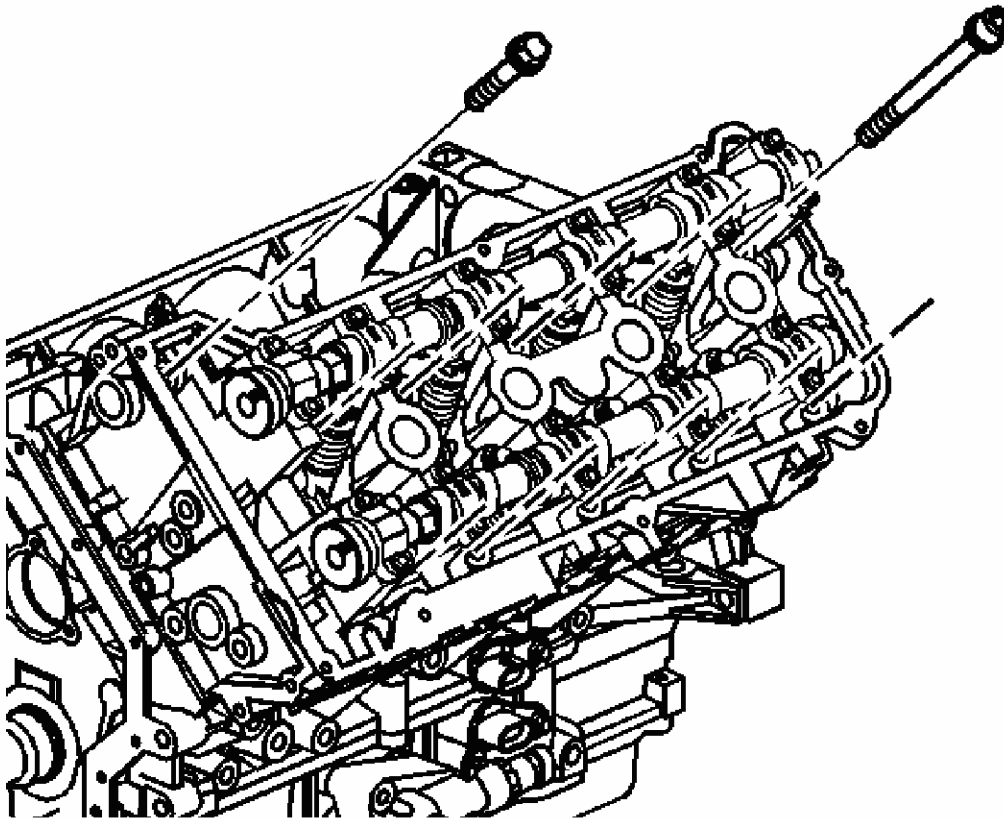


Fig. 342: Locating Cylinder Head External Drive Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the left exhaust manifold. Refer to **Exhaust Manifold Replacement - Left Side (RPO L26)** or **Exhaust Manifold Replacement - Left Side (RPO LD8)** .
2. Remove the engine mount strut bracket. Refer to **Engine Mount Strut Bracket Replacement - Right Side**.
3. Remove the generator. Refer to **Generator Replacement (RPO L26)** or **Generator Replacement (RPO LD8)** .
4. Remove the water crossover. Refer to **Engine Coolant Crossover Pipe Replacement (LD8)** .
5. Remove the intake manifold. Refer to **Intake Manifold Replacement**.
6. Remove the camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.
7. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
8. Remove the left secondary camshaft drive chain. Refer to **Secondary Camshaft Drive Chain Replacement - Left Side**.

9. Remove the 3 M6 cylinder head bolts.

IMPORTANT: DO NOT reuse the M11 cylinder head bolts.

10. Remove and discard the 10 M11 cylinder head bolts.

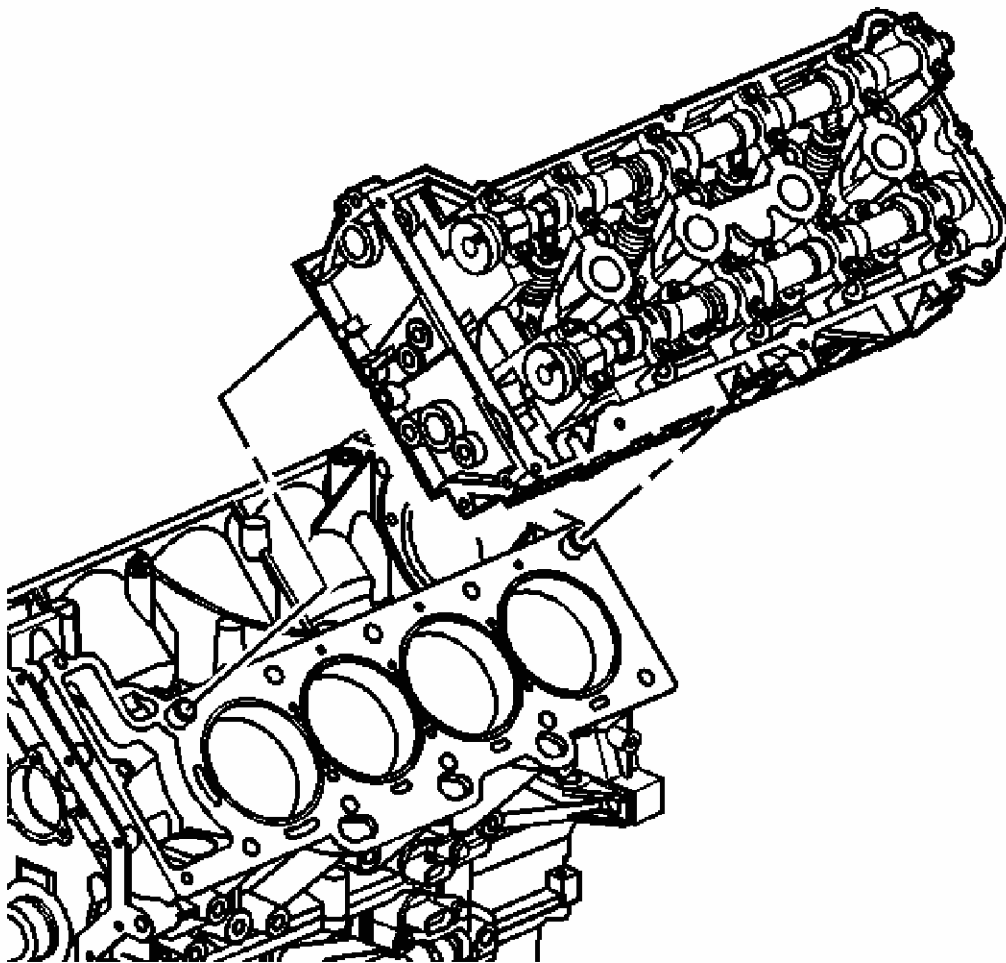


Fig. 343: View Of Cylinder Head With Alignment Dowels - Left
Courtesy of GENERAL MOTORS CORP.

11. Remove the left cylinder head. Make sure that no locating pins are stuck in the cylinder head.

IMPORTANT: You must clean the thread sealant material from the cylinder head bolt holes in the cylinder block. Failure to do

so could cause false torque readings during reassembly.

12. After removing the cylinder head, remove any remaining bolt thread sealant material from the threaded cylinder block holes.

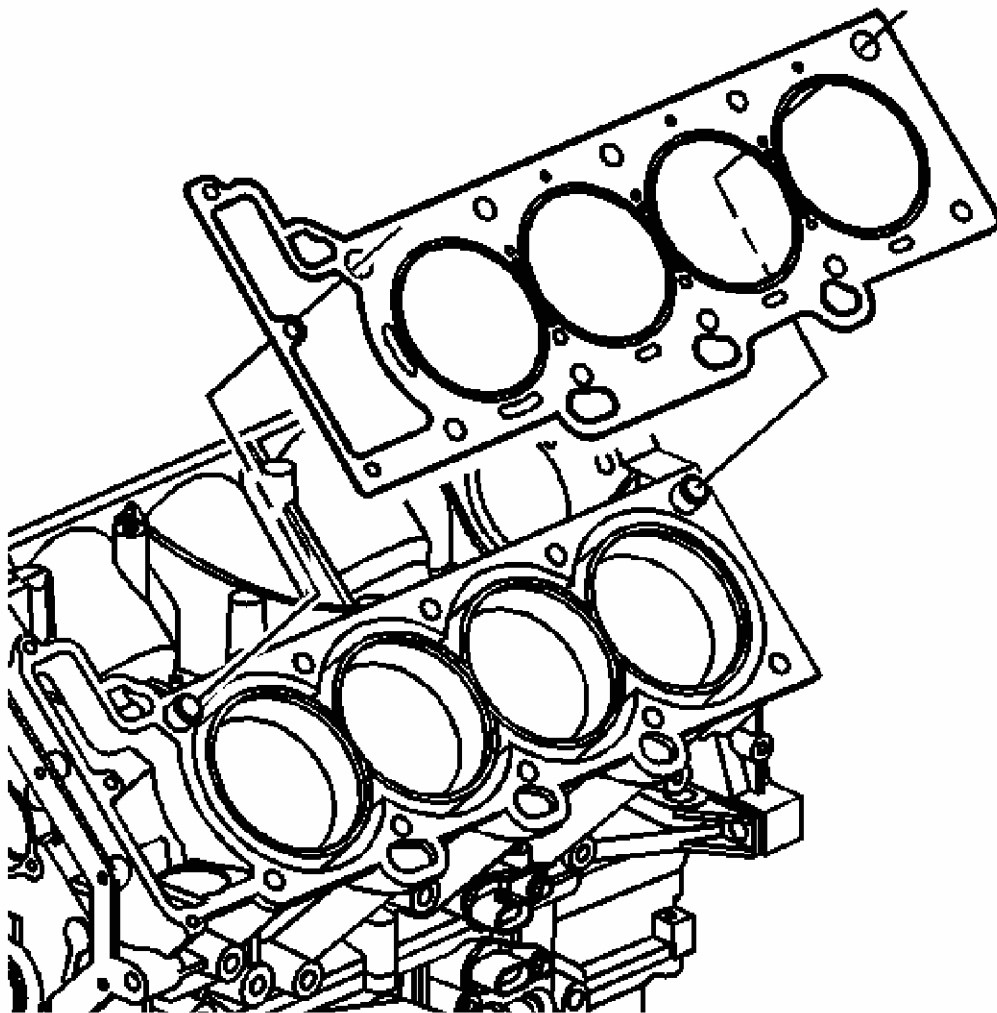


Fig. 344: View of Left Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: DO NOT reuse the cylinder head gasket.

13. Remove and discard the left cylinder head gasket.
14. Remove all remaining gasket material from the cylinder head and cylinder block using

the **J 28410** . See **Special Tools** .

15. Place the cylinder head on a clean, flat surface with the combustion chambers face-up in order to prevent damage to the deck face.
16. Clean and inspect the cylinder head. Refer to **Cylinder Head Cleaning and Inspection** .

INSTALLATION PROCEDURE

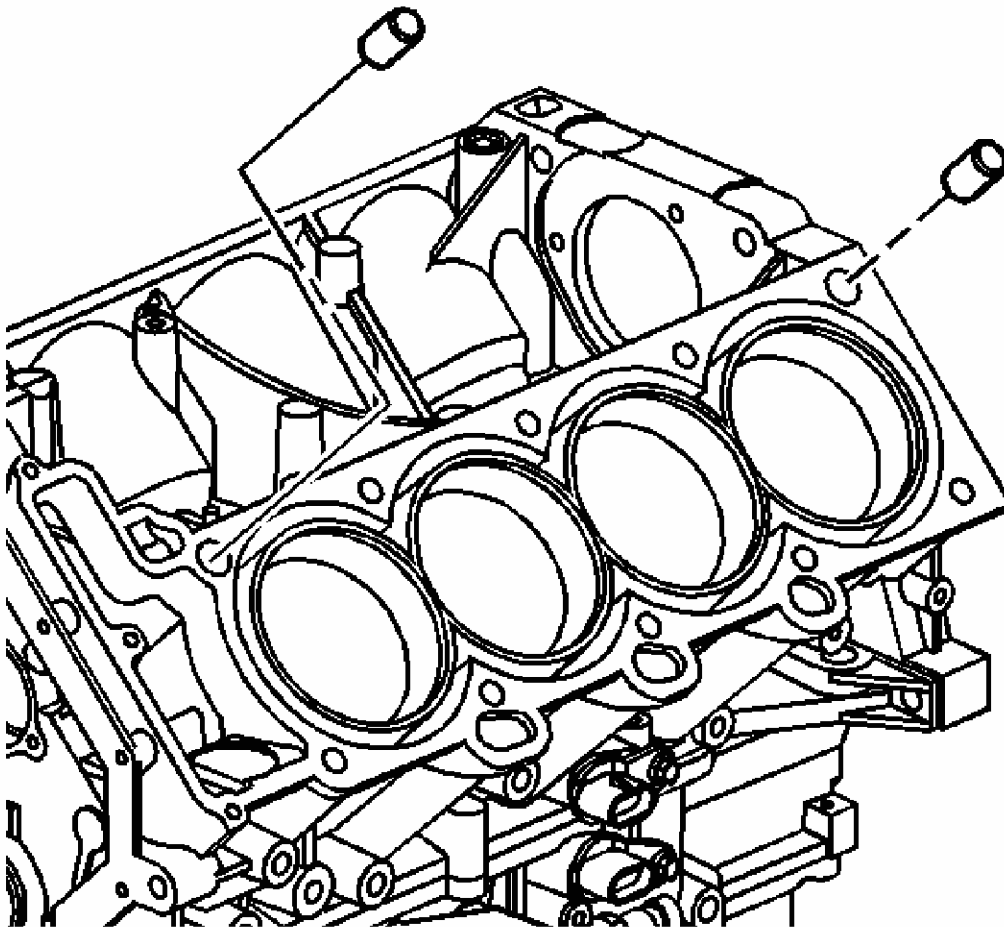


Fig. 345: Identifying Cylinder Head Locating Pins
Courtesy of GENERAL MOTORS CORP.

1. Make sure all the cylinder head locating pins are securely installed in the cylinder block deck face.

IMPORTANT: Failure to remove all the old thread sealant material from

the cylinder block could cause false torque readings.

2. Make sure all old thread sealant material is removed from the cylinder head bolt holes in the cylinder block.

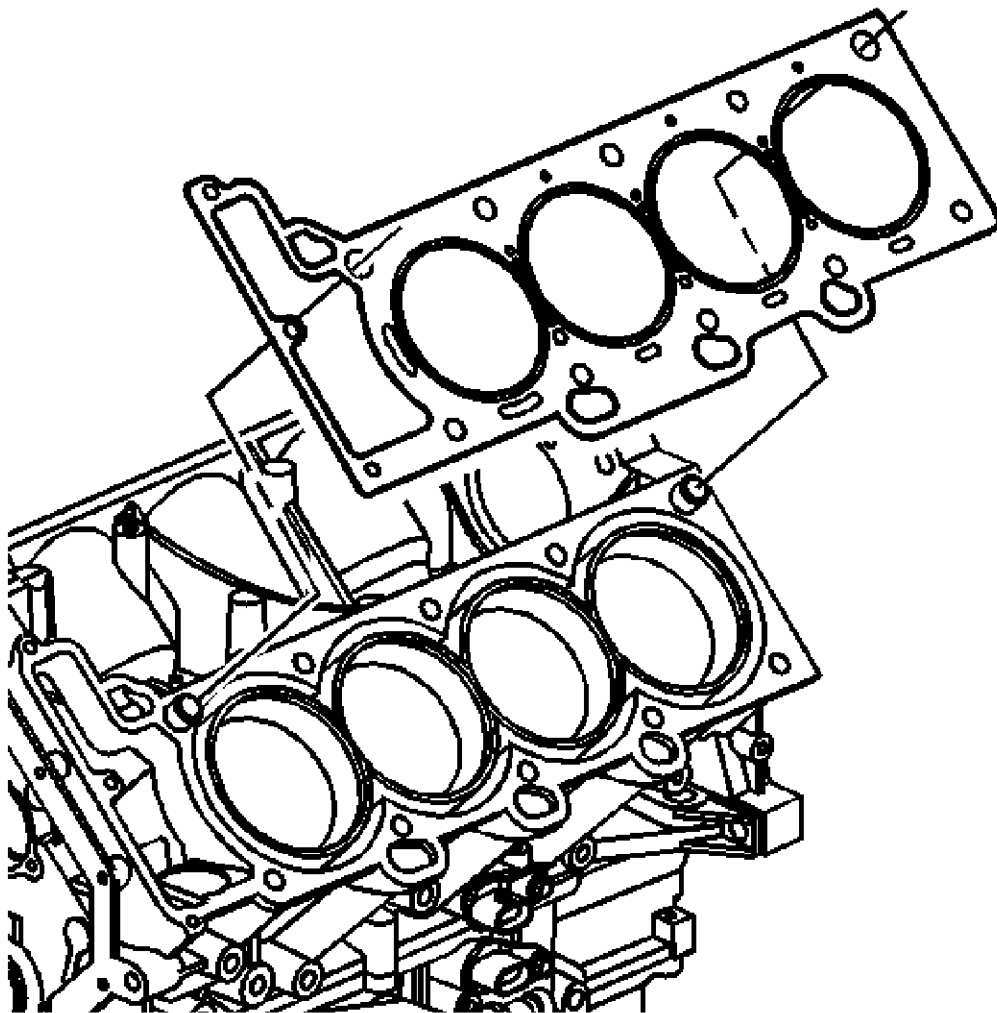


Fig. 346: View of Left Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

3. Install a NEW cylinder head gasket using the locating pins for retention.

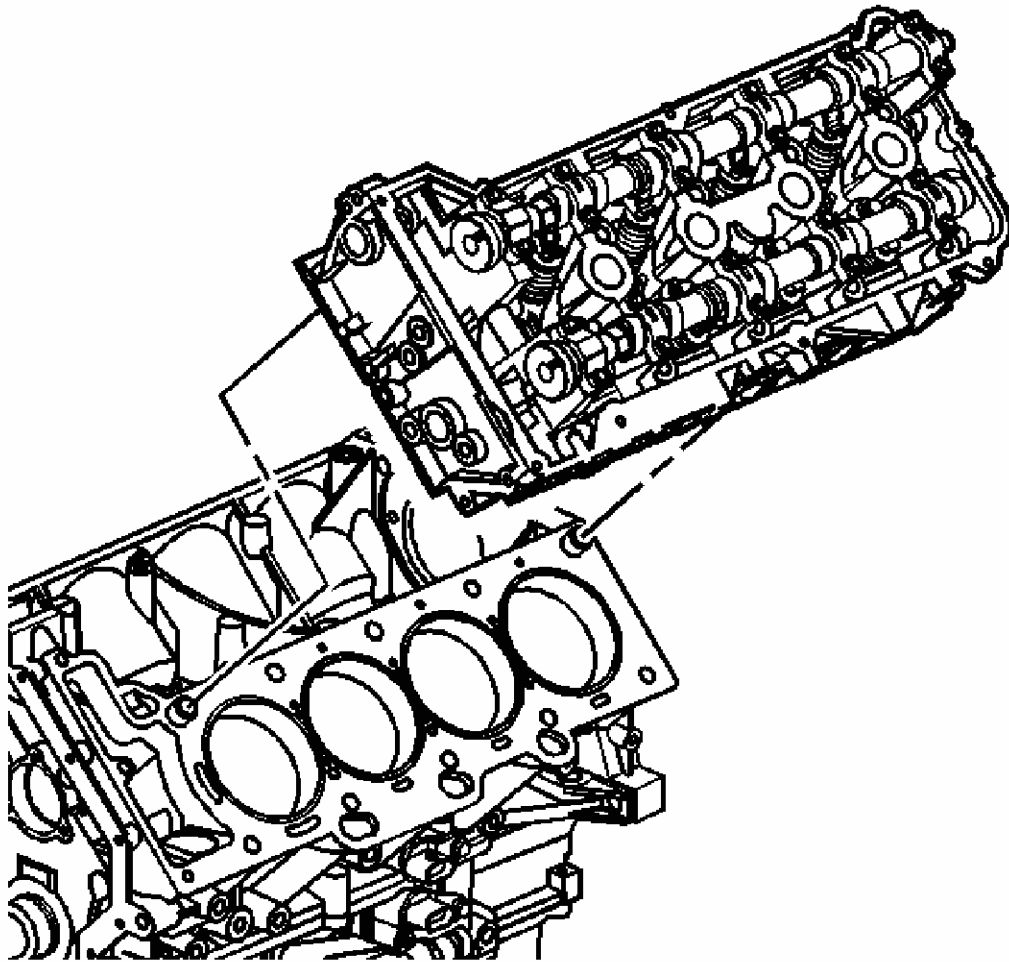


Fig. 347: View Of Cylinder Head With Alignment Dowels - Left
Courtesy of GENERAL MOTORS CORP.

4. Align the cylinder head with the locating pins.
5. Place the cylinder head in position on the cylinder block.

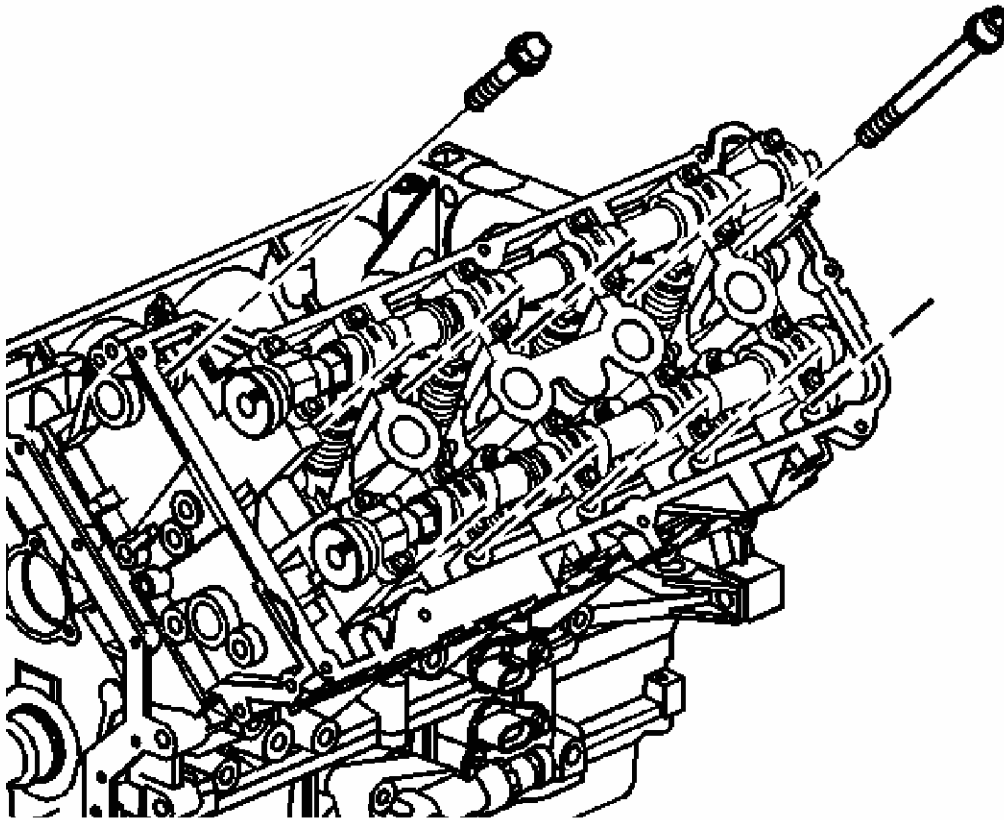


Fig. 348: Locating Cylinder Head External Drive Bolts
Courtesy of GENERAL MOTORS CORP.

6. Install 10 NEW M11 cylinder head bolts until snug.
7. Install the 3 M6 cylinder head bolts until snug.

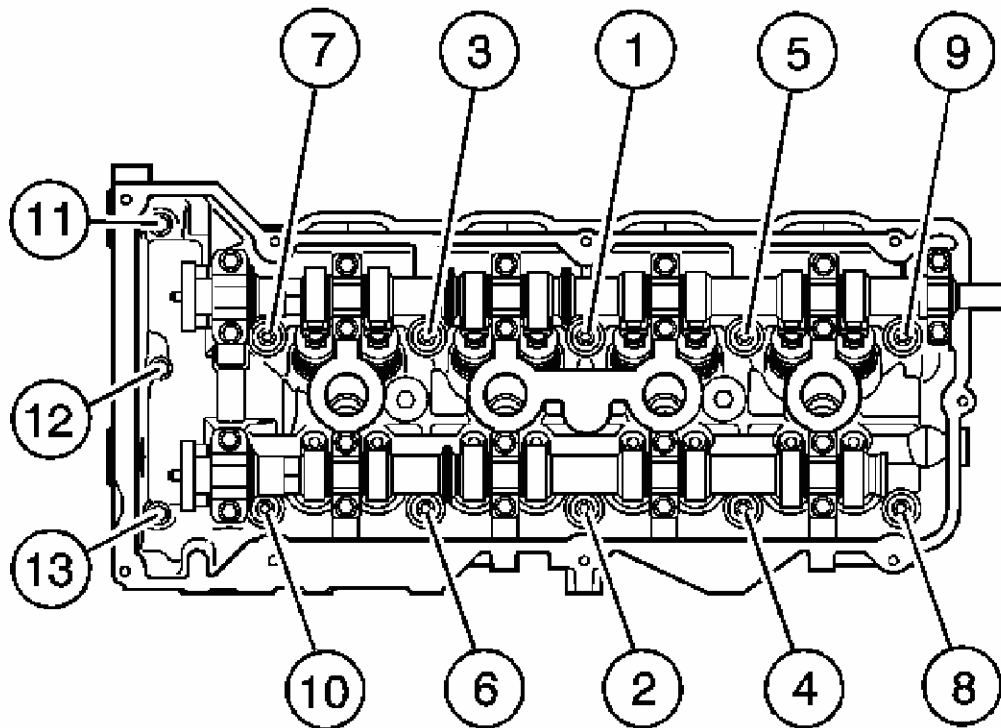


Fig. 349: Identifying Left Cylinder Head Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

8. Tighten the 10 M11 cylinder head bolts.

Tighten:

1. Tighten the bolts (1-10) a first pass in the sequence shown to 30 N.m (22 lb ft).
2. Tighten the bolts a second pass in the sequence shown an additional 70 degrees using the **J 45059** .
3. Tighten the bolts a third pass in the sequence shown an additional 60 degrees using the **J 45059** .
4. Tighten the bolts a final pass in the sequence shown an additional 45 degrees (total 175 degrees) using the **J 45059** .

9. Tighten the 3 M6 bolts cylinder head.

Tighten: Tighten the bolts to 12 N.m (106 lb in).

10. Install the left secondary camshaft drive chain. Refer to **Secondary Camshaft Drive Chain Replacement - Left Side.**
11. Install the engine front cover. Refer to **Engine Front Cover Replacement.**
12. Install the camshaft cover. Refer to **Camshaft Cover Replacement - Left Side.**
13. Install the intake manifold. Refer to **Intake Manifold Replacement.**
14. Install the water crossover. Refer to **Engine Coolant Crossover Pipe Replacement (LD8) .**
15. Install the generator. Refer to **Generator Replacement (RPO L26)** or **Generator Replacement (RPO LD8) .**
16. Install the engine mount strut bracket. Refer to **Engine Mount Strut Bracket Replacement - Right Side.**
17. Install the left exhaust manifold. Refer to **Exhaust Manifold Replacement - Left Side (RPO L26)** or **Exhaust Manifold Replacement - Left Side (RPO LD8) .**

CYLINDER HEAD REPLACEMENT - RIGHT SIDE

TOOLS REQUIRED

- **J 28410** Gasket Remover. See **Special Tools** .
- **J 45059** Angle Meter

REMOVAL PROCEDURE

1. Remove the right exhaust manifold. Refer to **Exhaust Manifold Replacement - Right Side (RPO L26)** or **Exhaust Manifold Replacement - Right Side (RPO LD8) .**
2. Remove the water crossover. Refer to **Engine Coolant Crossover Pipe Replacement (LD8) .**
3. Remove the intake manifold. Refer to **Intake Manifold Replacement.**
4. Remove the camshaft cover. Refer to **Camshaft Cover Replacement - Right Side.**
5. Remove the engine front cover. Refer to **Engine Front Cover Replacement.**
6. Remove the right secondary camshaft drive chain. Refer to **Secondary Camshaft Drive Chain Replacement - Right Side.**

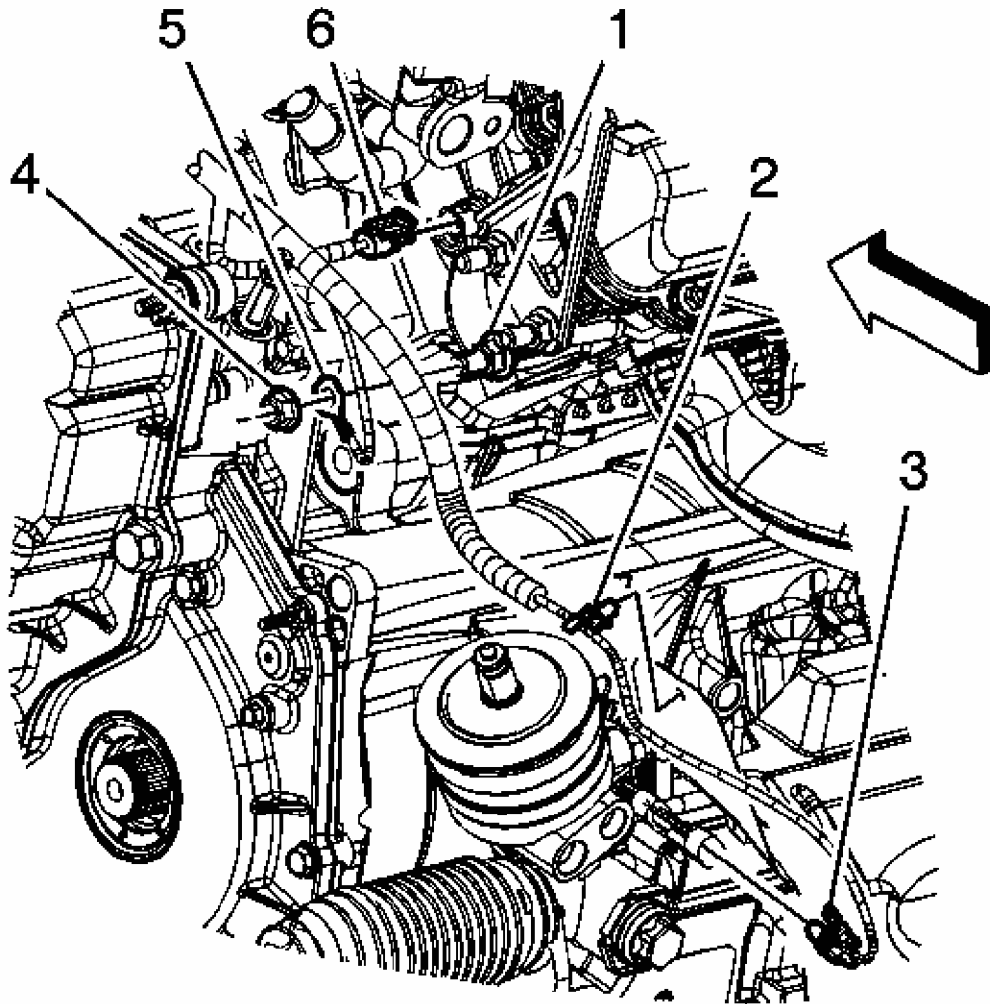


Fig. 350: Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

7. Disconnect the engine harness electrical connector (6) from the engine coolant temperature (ECT) sensor.
8. Remove the engine harness ground terminal nut (4).
9. Remove the engine harness ground terminal (5).

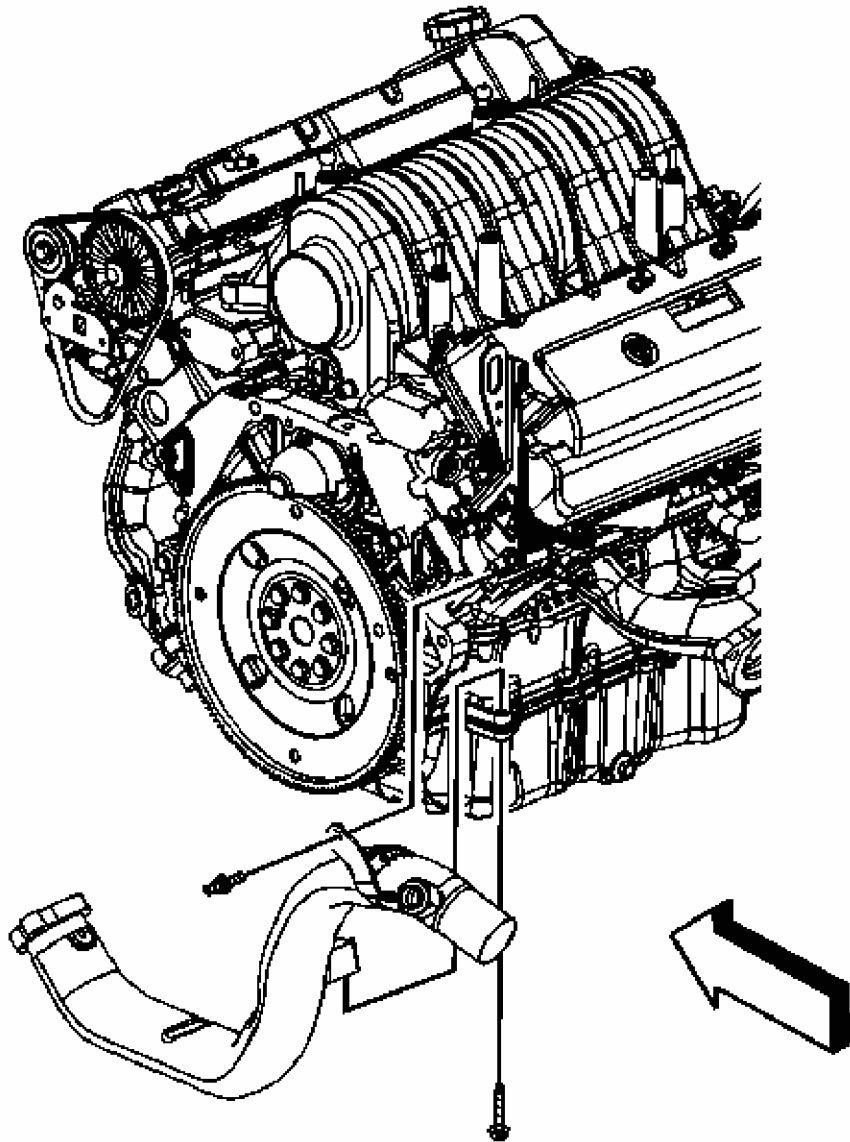


Fig. 351: Identifying Front Exhaust Manifold Pipe
Courtesy of GENERAL MOTORS CORP.

10. Remove the stud attaching the exhaust manifold front pipe to the cylinder head.
11. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

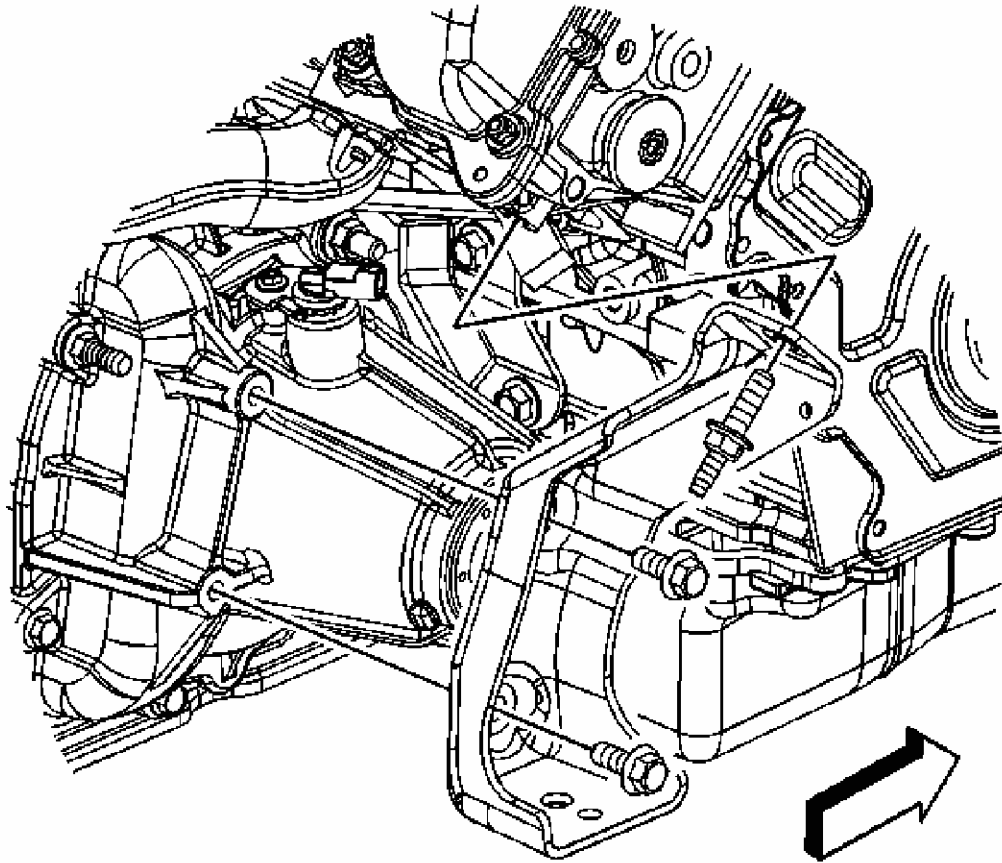


Fig. 352: Identifying Right Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

12. Remove the stud attaching the right engine mount bracket to the cylinder head.
13. Loosen the bolts attaching the engine mount bracket to the transaxle.
14. Remove the bolt attaching the transaxle brace to the transaxle.
15. Lower the vehicle.

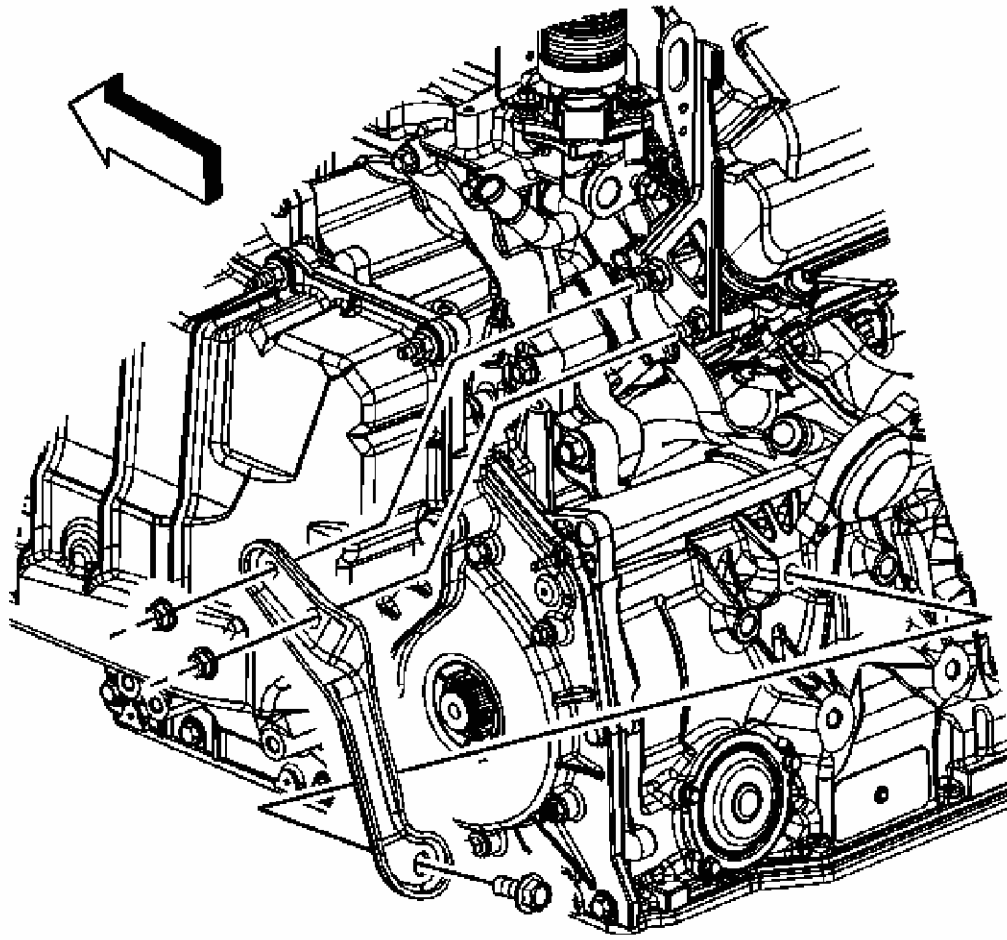


Fig. 353: Identifying Engine Lift Bracket
Courtesy of GENERAL MOTORS CORP.

16. Remove the nuts attaching the transaxle brace to the lift bracket studs.
17. Remove the transaxle brace.

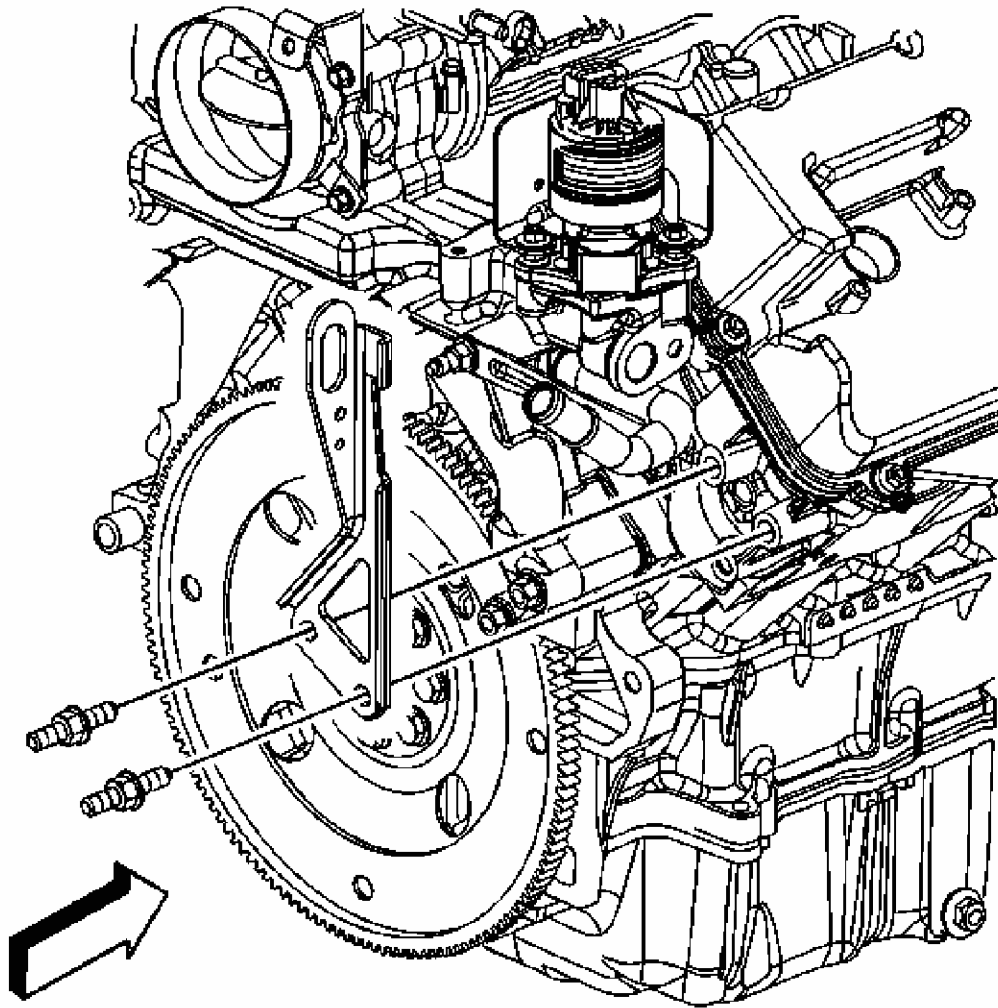


Fig. 354: Identifying Engine Rear Lift Bracket Studs
Courtesy of GENERAL MOTORS CORP.

18. Remove the rear lift bracket studs.
19. Remove the rear lift bracket.

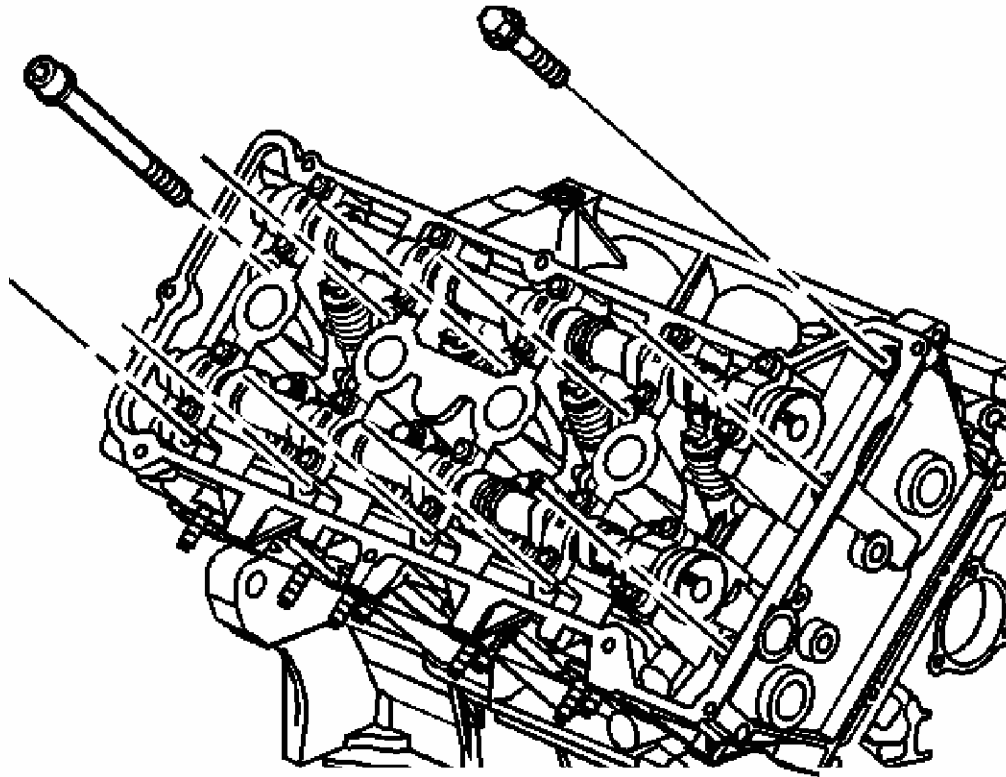


Fig. 355: Identifying M6 External Drive Bolts
Courtesy of GENERAL MOTORS CORP.

20. Remove the 3 M6 cylinder head bolts.

IMPORTANT: DO NOT reuse the M11 cylinder head bolts.

21. Remove and discard the 10 M11 cylinder head bolts.

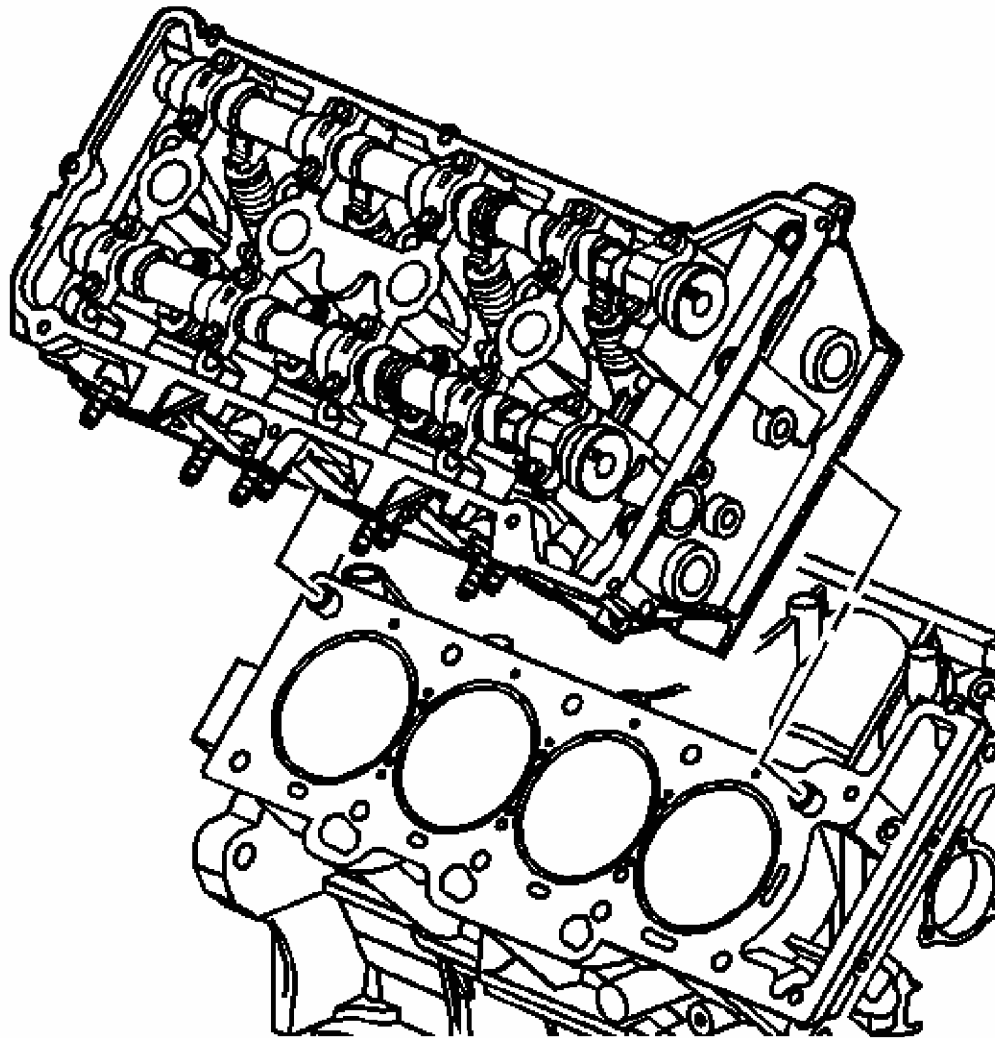


Fig. 356: View Of Cylinder Head With Alignment Dowels - Right
Courtesy of GENERAL MOTORS CORP.

22. Remove the right cylinder head. Make sure that no locating pins are stuck in the cylinder head.

IMPORTANT: You must clean the thread sealant material from the cylinder head bolt holes in the cylinder block. Failure to do so could cause false torque readings during reassembly.

23. After removing the cylinder head, remove any remaining bolt thread sealant material from the threaded cylinder block holes.

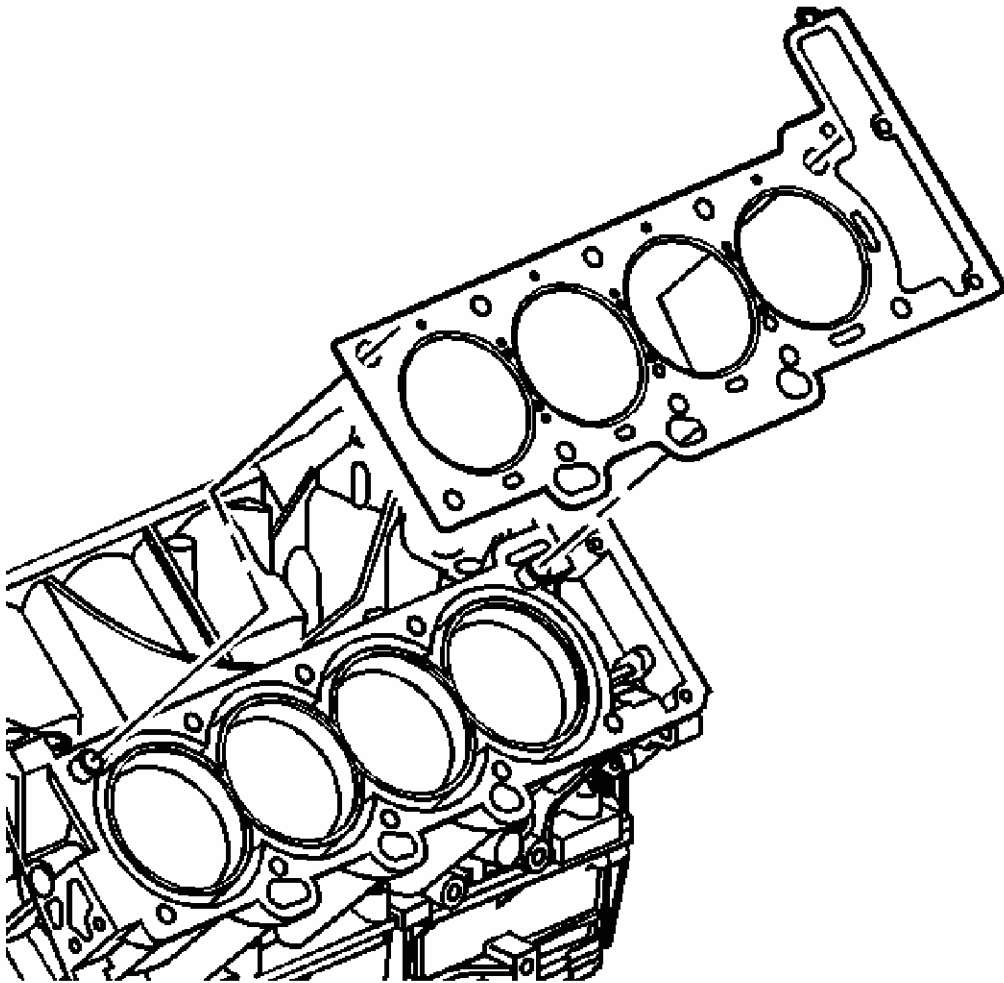


Fig. 357: View of Right Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: DO NOT reuse the cylinder head gasket.

24. Remove and discard the right cylinder head gasket.
25. Remove all remaining gasket material from the cylinder head and cylinder block using the **J 28410** . See **Special Tools** .
26. Place the cylinder head on a clean, flat surface with the combustion chambers face-up in order to prevent damage to the deck face.
27. Clean and inspect the cylinder head. Refer to **Cylinder Head Cleaning and Inspection** .

INSTALLATION PROCEDURE

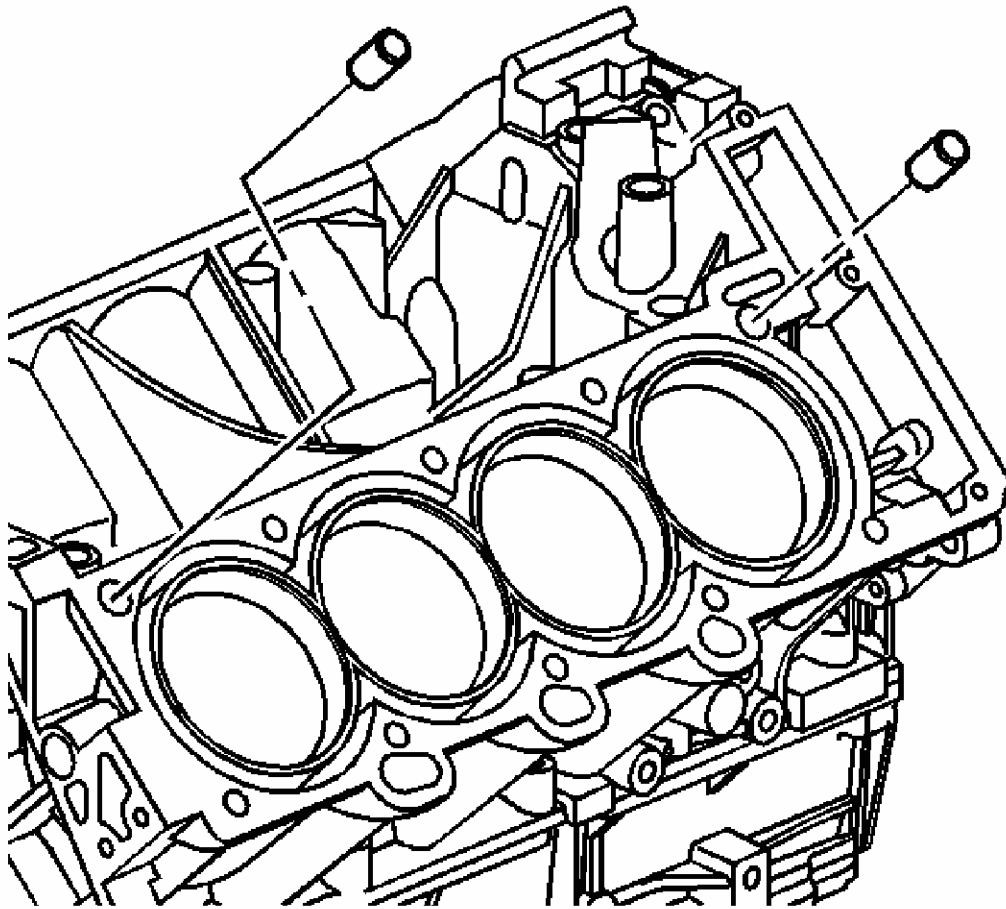


Fig. 358: Identifying Cylinder Head Locating Pins
Courtesy of GENERAL MOTORS CORP.

1. Make sure the locating pins are securely mounted in the cylinder block deck face.

IMPORTANT: Failure to remove all the old thread sealant material from the cylinder block could cause false torque readings.

2. Make sure any old thread sealant material is removed from the cylinder head bolt holes in the cylinder block.

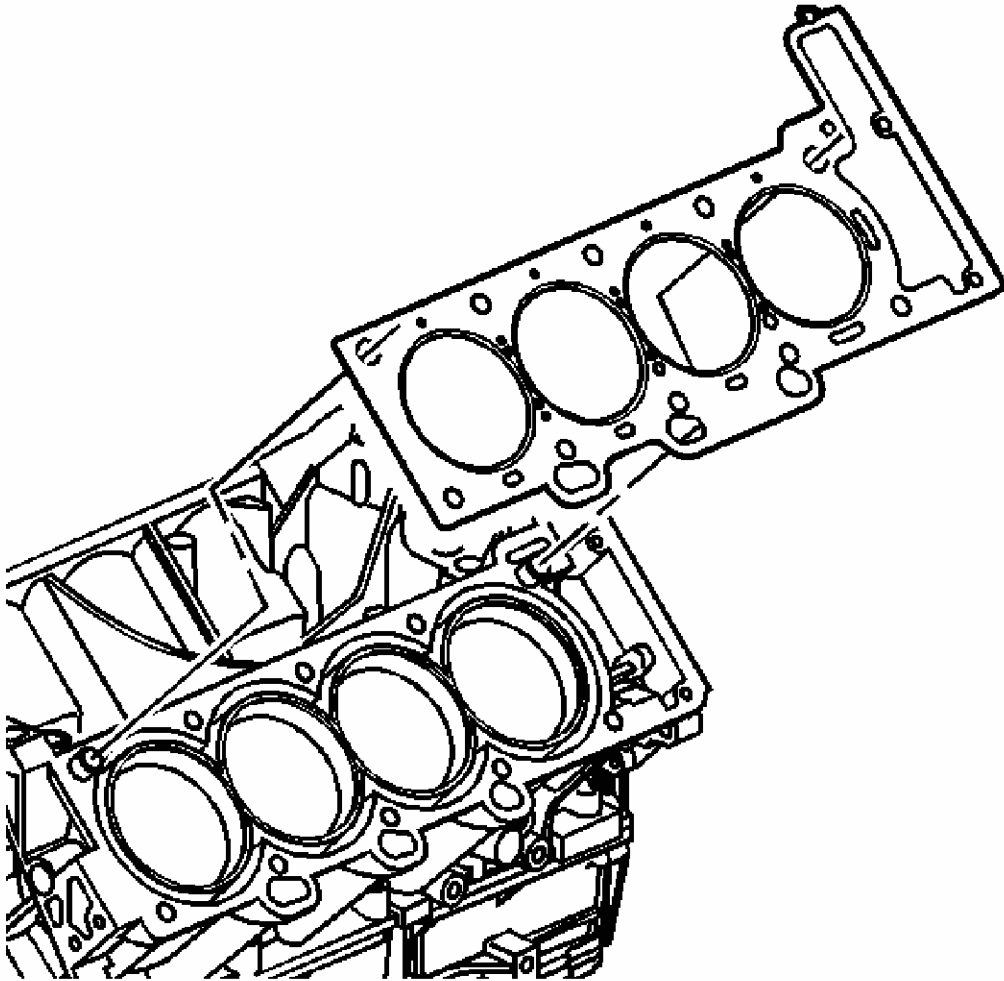


Fig. 359: View of Right Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

3. Install a NEW cylinder head gasket using the locating pins for retention.

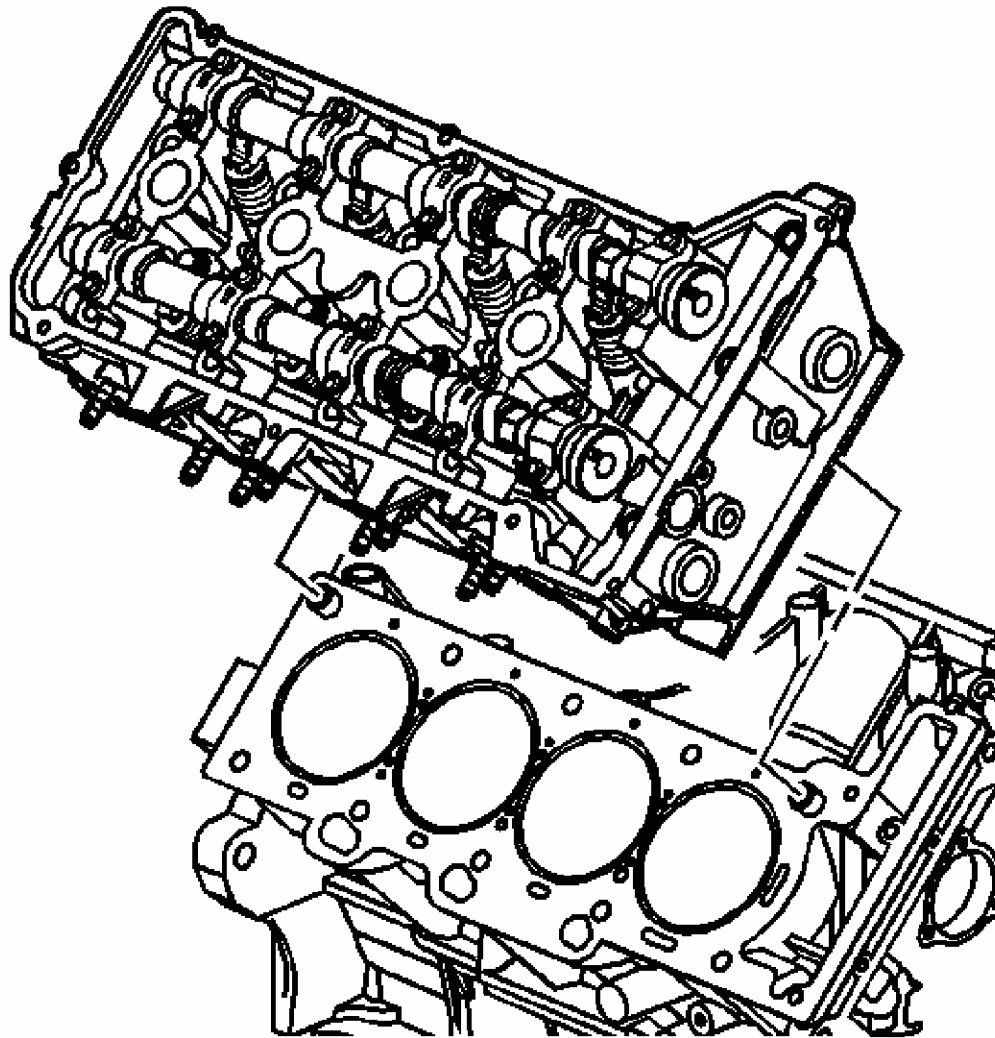


Fig. 360: View Of Cylinder Head With Alignment Dowels - Right
Courtesy of GENERAL MOTORS CORP.

4. Align the cylinder head with the locating pins.
5. Place the cylinder head in position on the cylinder block.

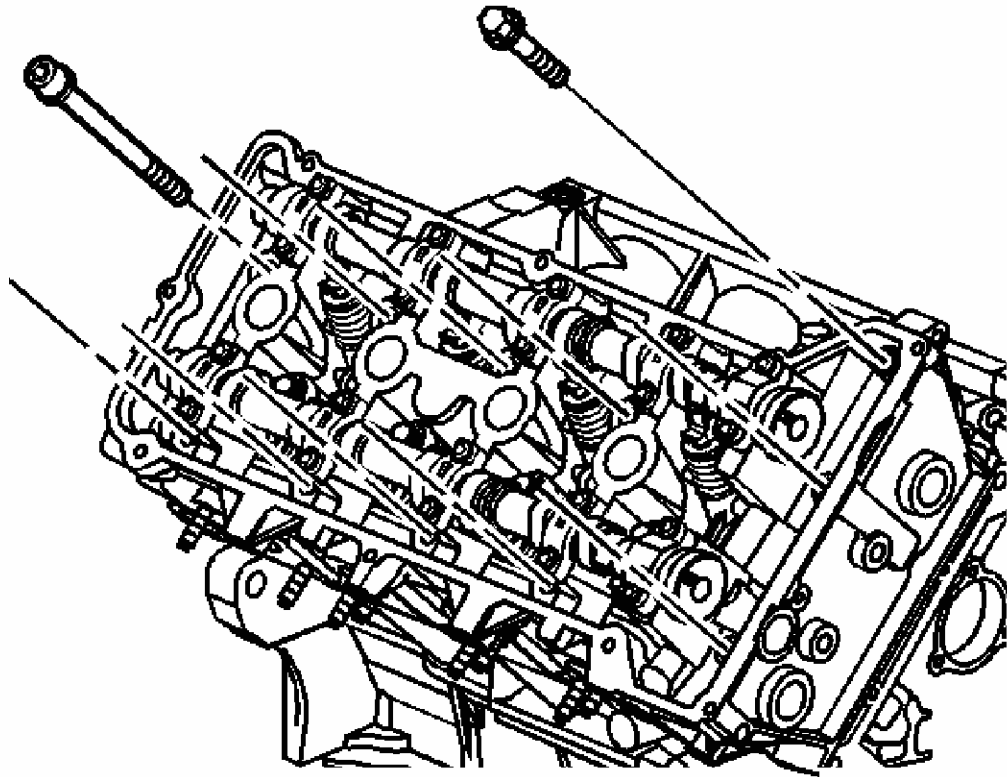


Fig. 361: Identifying M6 External Drive Bolts
Courtesy of GENERAL MOTORS CORP.

6. Install NEW M11 cylinder head bolts until snug.
7. Install the M6 cylinder head bolts until snug.

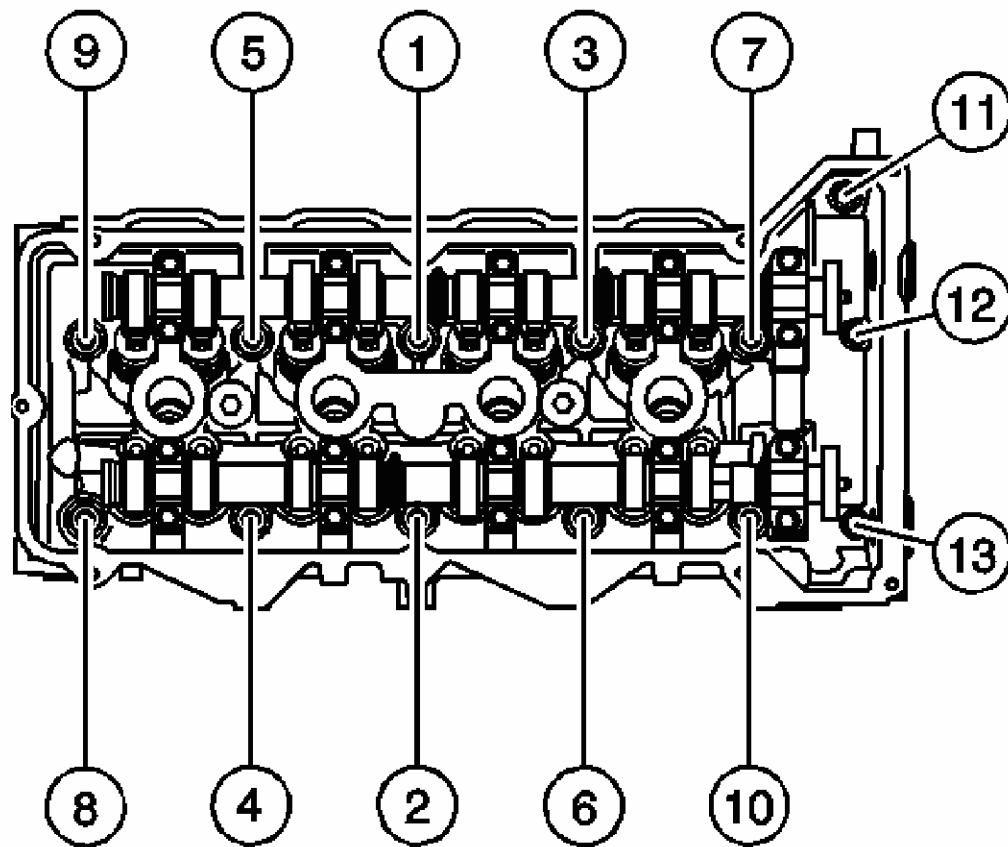


Fig. 362: Identifying Right Cylinder Head Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

8. Tighten the M11 cylinder head bolts.

Tighten:

1. Tighten the bolts (1-10) a first pass in the sequence shown to 30 N.m (22 lb ft).
2. Tighten the bolts a second pass in the sequence shown an additional 70 degrees using the **J 45059** .
3. Tighten the bolts a third pass in the sequence shown an additional 60 degrees using the **J 45059** .
4. Tighten the bolts a final pass in the sequence shown an additional 45 degrees (total 175 degrees) using the **J 45059** .

9. Tighten the M6 cylinder head bolts.

Tighten: Tighten the bolts to 12 N.m (106 lb in).

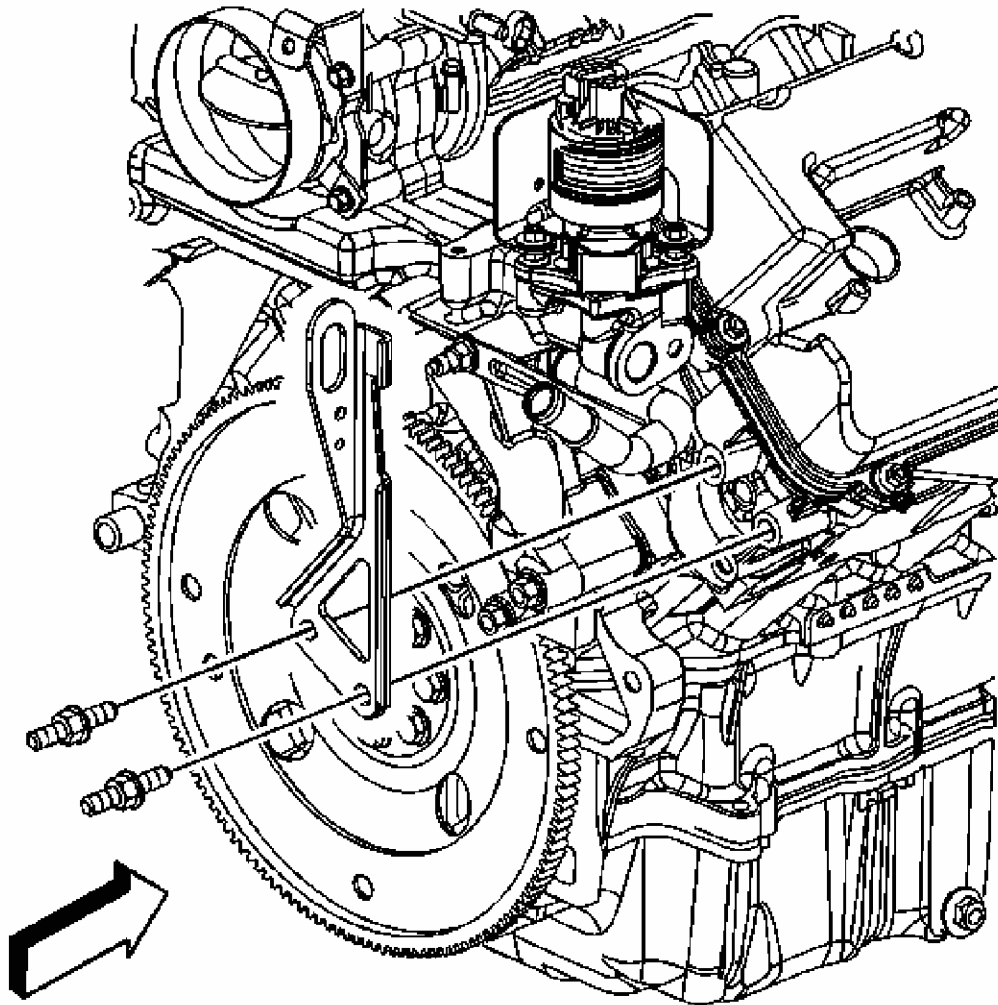


Fig. 363: Identifying Engine Lift Bracket Studs
Courtesy of GENERAL MOTORS CORP.

10. Position the rear lift bracket to the cylinder head.
11. Install the rear lift bracket studs.

Tighten: Tighten the studs to 50 N.m (37 lb ft).

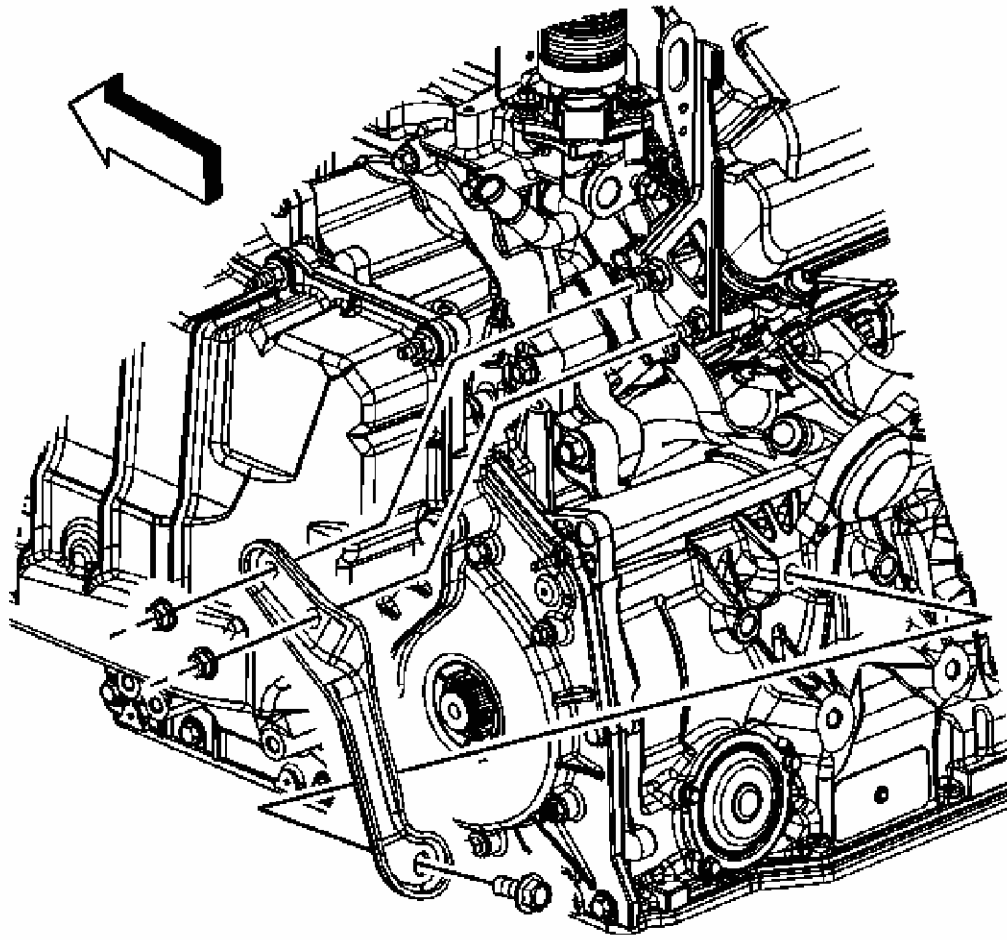


Fig. 364: Identifying Engine Lift Bracket
Courtesy of GENERAL MOTORS CORP.

12. Install the transaxle brace to the lift bracket studs.
13. Install the nuts attaching the transaxle brace to the lift bracket studs.

Tighten: Tighten the nuts to 50 N.m (37 lb ft).

14. Raise the vehicle.
15. Install the bolt attaching the transaxle brace to the transaxle.

Tighten: Tighten the bolt to 50 N.m (37 lb ft).

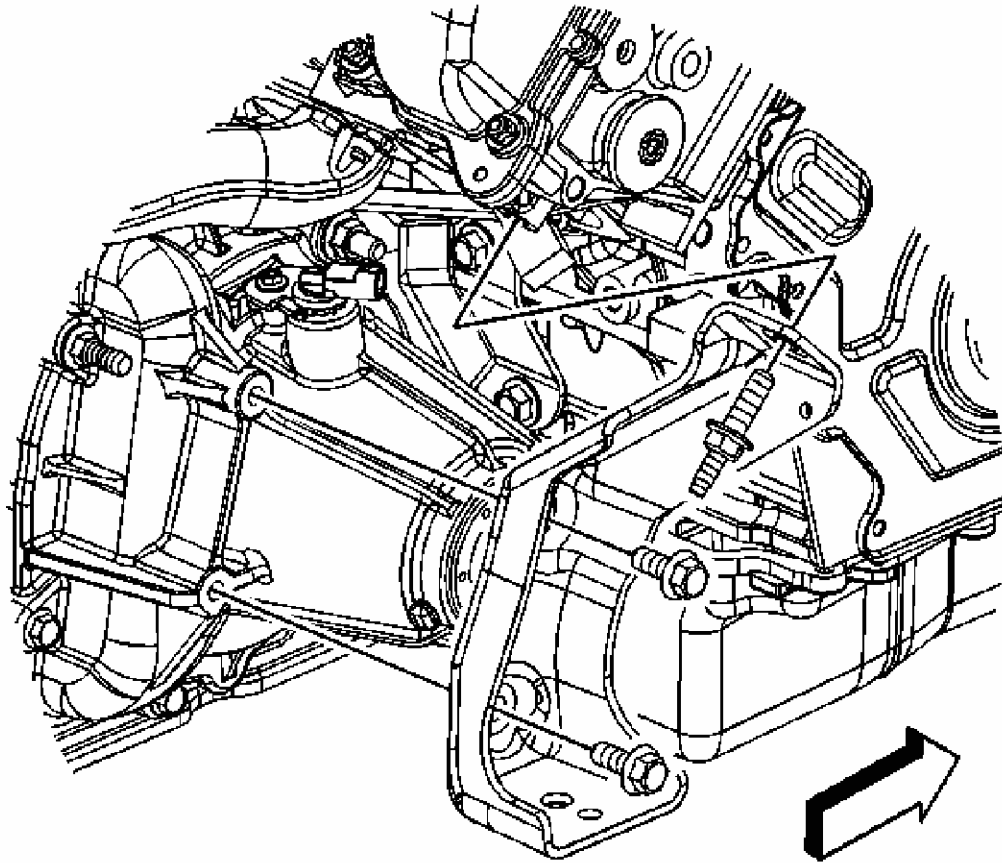


Fig. 365: Identifying Right Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

16. Install the stud attaching the right engine mount bracket to the cylinder head.

Tighten: Tighten the bolt to 73 N.m (54 lb ft).

17. Tighten the bolts attaching the engine mount bracket to the transaxle.

Tighten: Tighten the bolt to 73 N.m (54 lb ft).

18. Lower the vehicle.

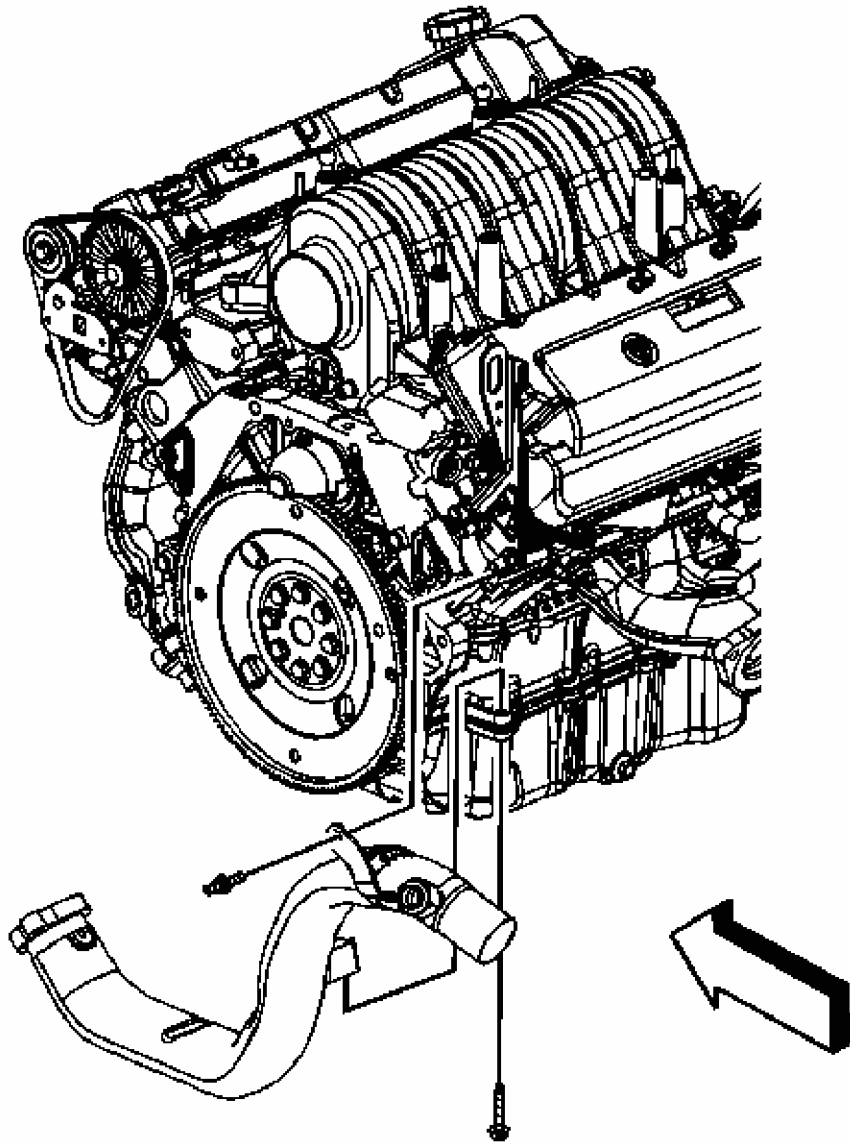


Fig. 366: Identifying Front Exhaust Manifold Pipe
Courtesy of GENERAL MOTORS CORP.

19. Install the stud attaching the exhaust manifold front pipe to the cylinder head.

Tighten: Tighten the stud to 25 N.m (18 lb ft).

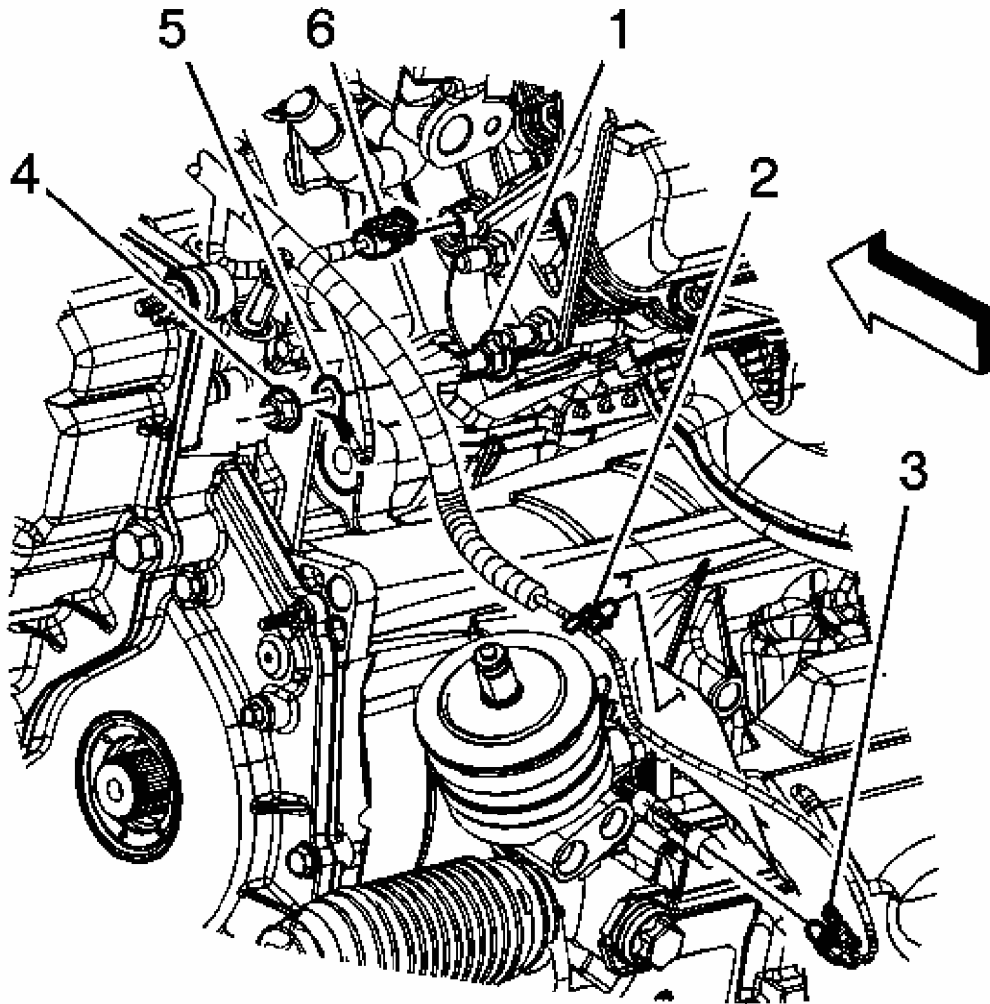


Fig. 367: Locating Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

20. Install the engine harness ground terminal (5) onto the stud (1).
21. Install the engine harness ground terminal nut (4).

Tighten: Tighten the nut to 17 N.m (13 lb ft).

22. Connect the engine harness electrical connector (6) to the ECT sensor.
23. Install the right secondary camshaft drive chain. Refer to **Secondary Camshaft Drive Chain Replacement - Right Side**.
24. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

25. Install the camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.
26. Install the intake manifold. Refer to **Intake Manifold Replacement**.
27. Install the water crossover. Refer to **Engine Coolant Crossover Pipe Replacement (LD8)** .
28. Install the right exhaust manifold. Refer to **Exhaust Manifold Replacement - Right Side (RPO L26)** or **Exhaust Manifold Replacement - Right Side (RPO LD8)** .

ENGINE FLYWHEEL REPLACEMENT

TOOLS REQUIRED

- **J 45059** Angle Meter
- **J 44214** Flywheel Holder. See **Special Tools** .

REMOVAL PROCEDURE

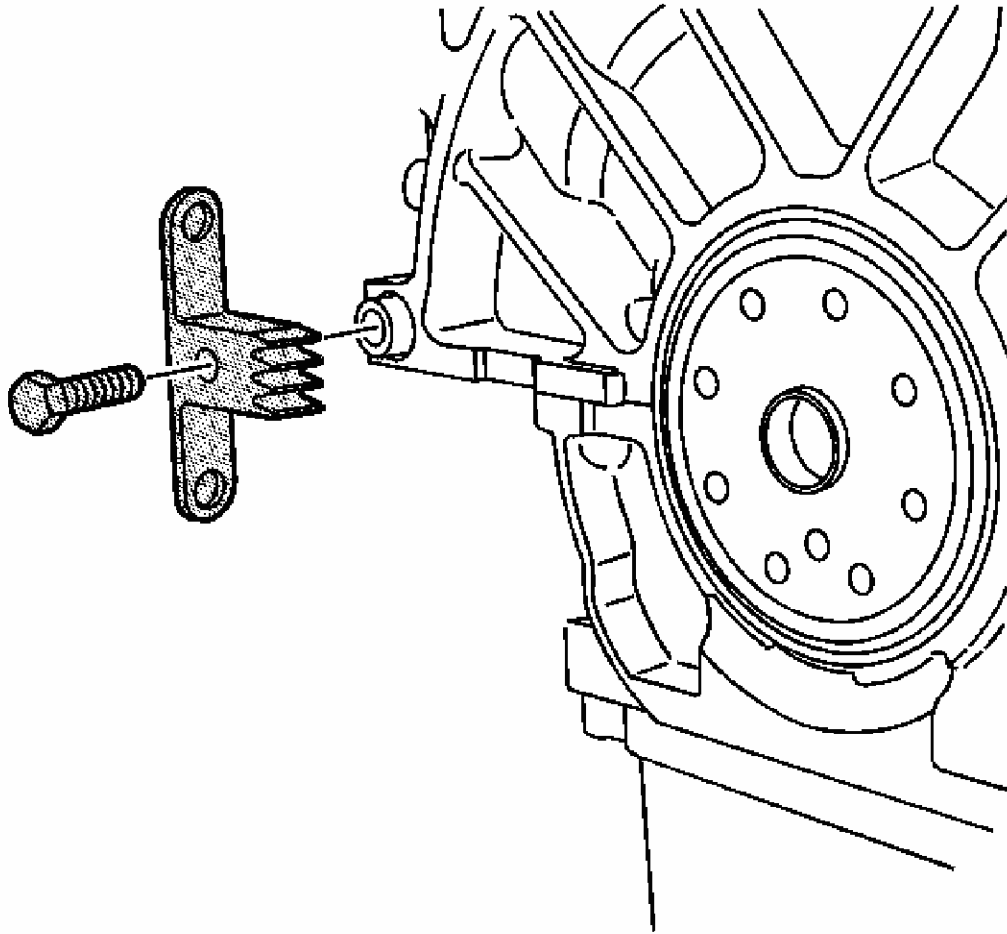


Fig. 368: View Of J 44214 & Engine Block
Courtesy of GENERAL MOTORS CORP.

1. Remove the transaxle. Refer to **Transmission Replacement** .
2. Install the **J 44214** to the engine block. See **Special Tools** .

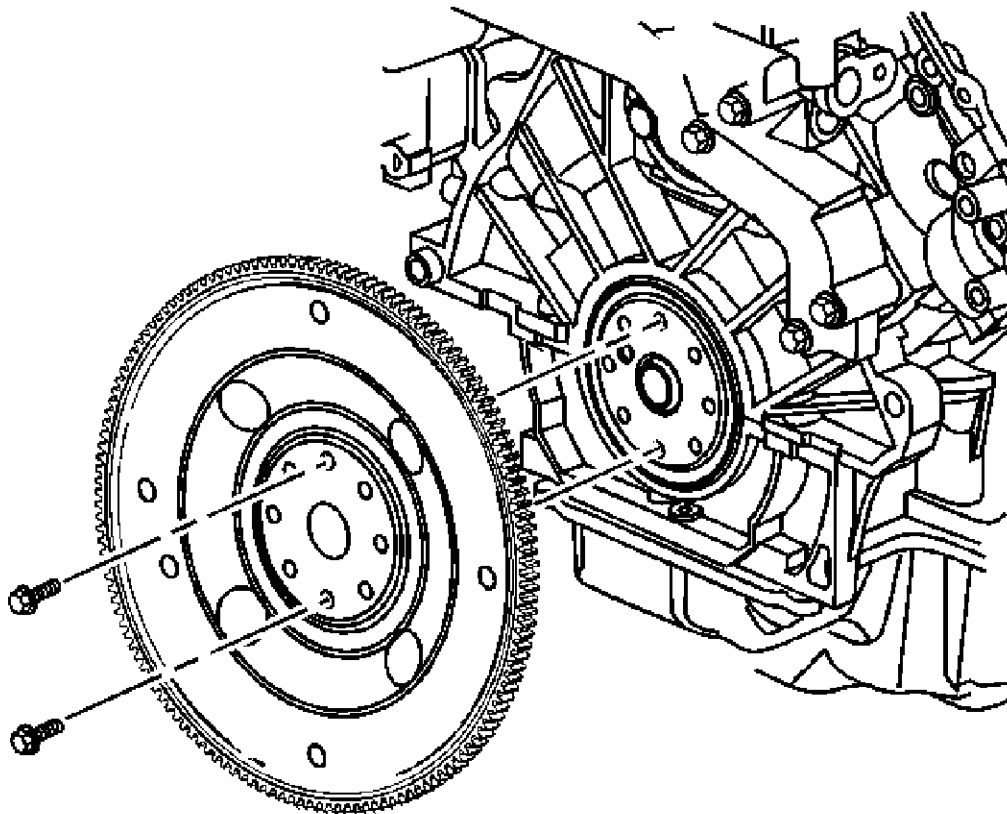


Fig. 369: Identifying 8 Engine Flywheel Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

3. Loosen the flywheel bolts.
4. Remove all but one of the flywheel bolts, leaving the one bolt at the top of the crankshaft.
5. Grasp the engine flywheel with one hand and remove the remaining bolt. Do not drop the engine flywheel when removing the final bolt.
6. Clean and inspect the engine flywheel. Refer to **Engine Flywheel Cleaning and Inspection** .

INSTALLATION PROCEDURE

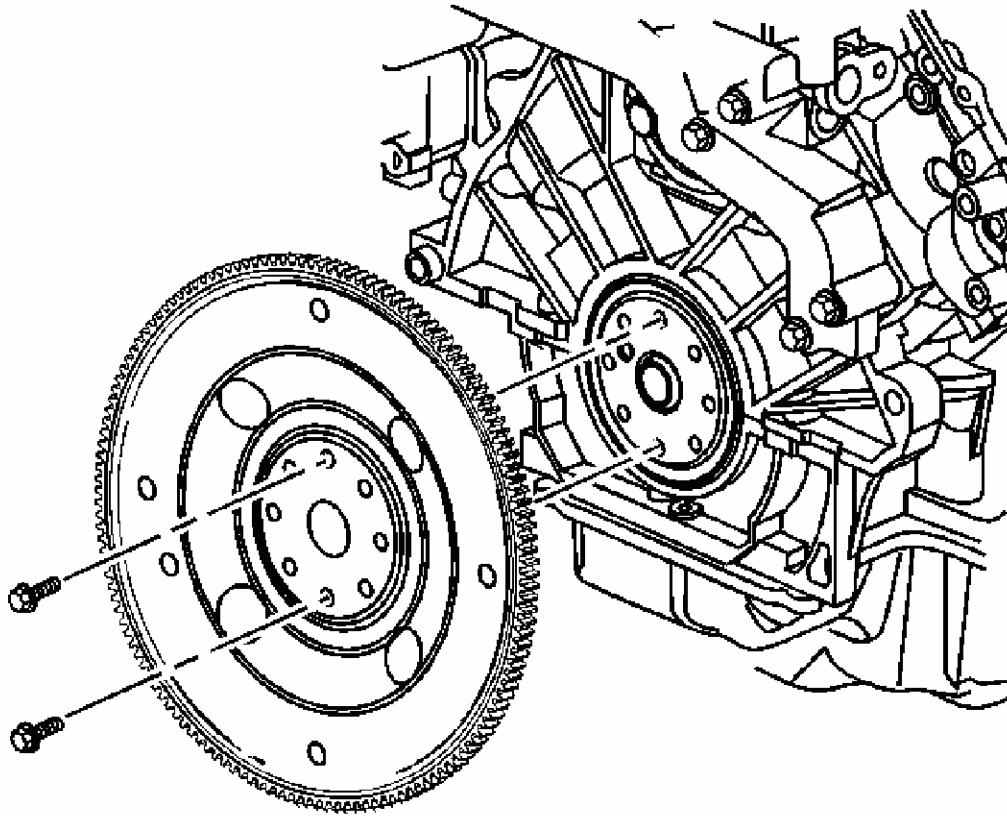


Fig. 370: Identifying 8 Engine Flywheel Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

1. Apply sealant to the flywheel bolts. Refer to Sealers, Adhesives and Lubricants .
2. Place the engine flywheel in position against the crankshaft.

NOTE: Refer to Fastener Notice .

3. Install the flywheel bolts.

Tighten:

- Tighten the bolts a first pass to 30 N.m (22 lb ft).
- Tighten the bolts a final pass an additional 50 degrees using the **J 45059** .

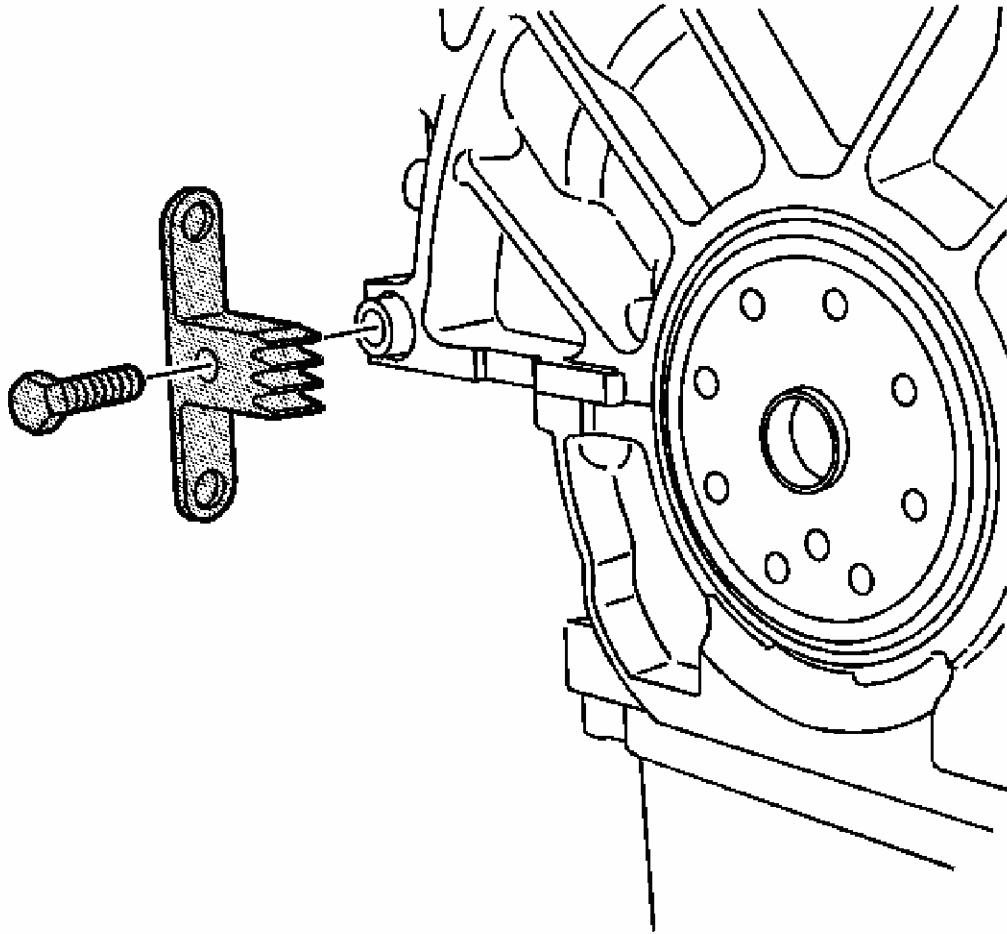


Fig. 371: View Of J 44214 & Engine Block
Courtesy of GENERAL MOTORS CORP.

4. Remove the **J 44214** from the engine block. See **Special Tools** .
5. Install the transaxle. Refer to **Transmission Replacement** .

OIL PAN REPLACEMENT

TOOLS REQUIRED

EN 46109 Engine Front Cover Installation Guide Pins. See **Special Tools** .

REMOVAL PROCEDURE

1. Drain the engine oil. Refer to **Engine Oil and Oil Filter Replacement** .

2. Remove the front exhaust manifold pipe. Refer to **Exhaust Manifold Front Pipe Replacement (RPO LD8)** .

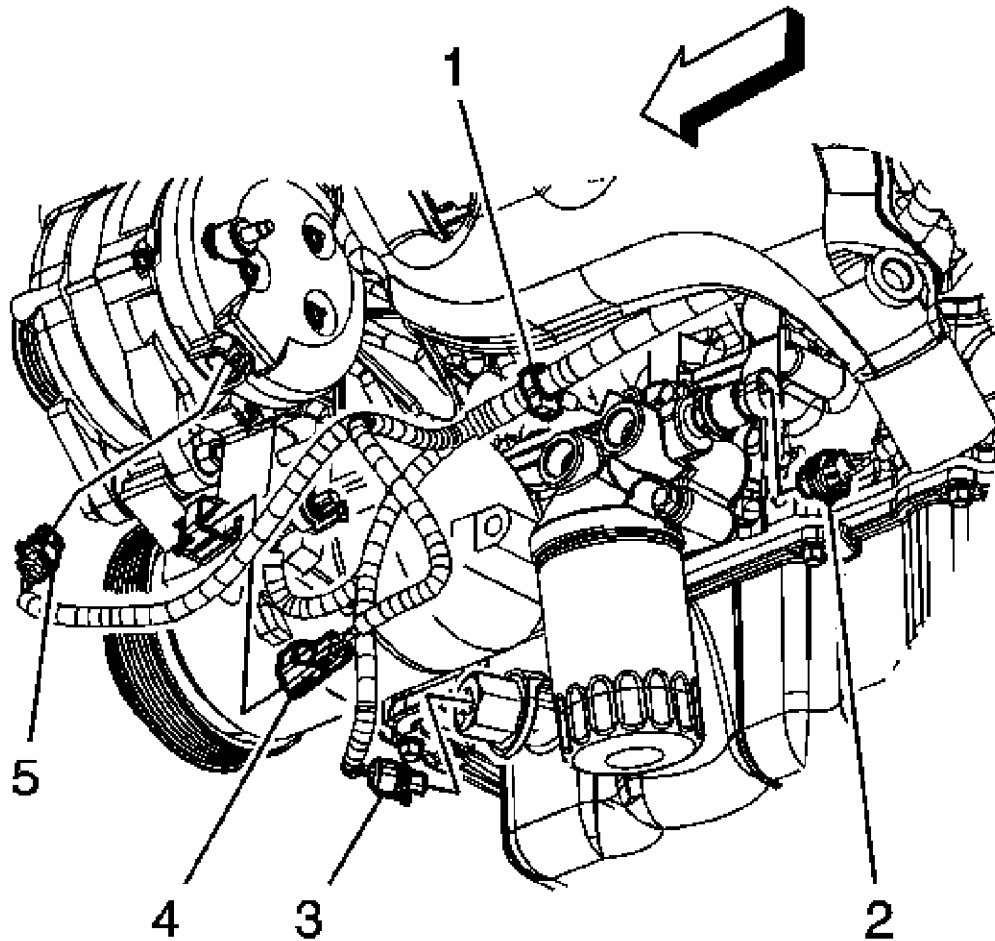


Fig. 372: Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

3. Disconnect the engine harness electrical connector (2) from the oil level sensor.

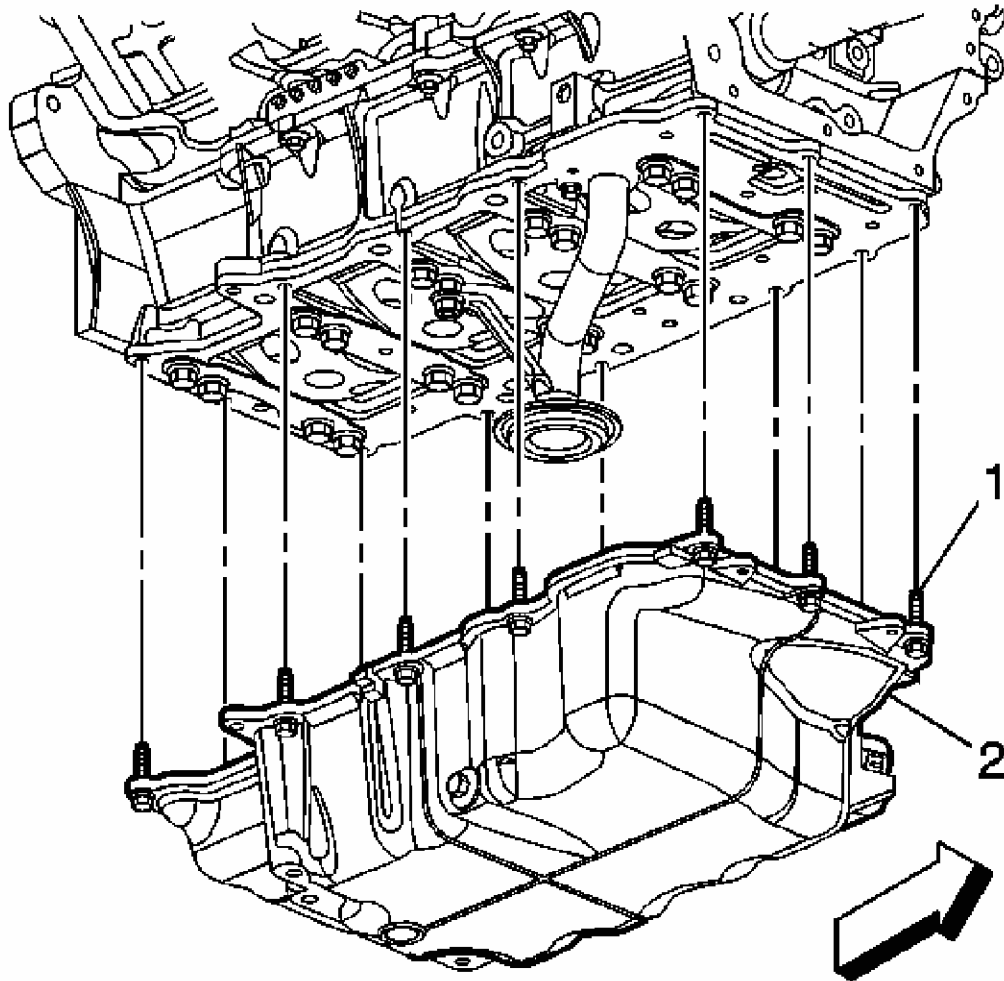


Fig. 373: View Of Oil Pan

Courtesy of GENERAL MOTORS CORP.

4. Loosen the oil pan bolts (1).
5. Remove the oil pan (2) and discard the oil pan gasket.

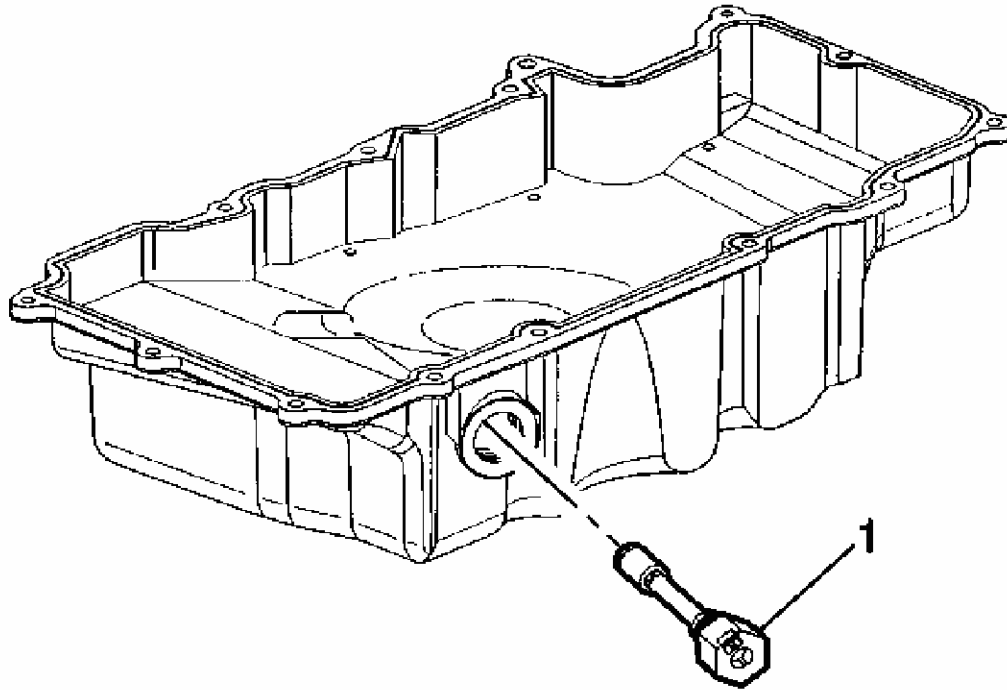


Fig. 374: Identifying Oil Level Sensor
Courtesy of GENERAL MOTORS CORP.

6. Remove the oil level sensor (1), if necessary.
7. Clean and inspect the oil pan, if necessary. Refer to **Oil Pan Cleaning and Inspection** .

INSTALLATION PROCEDURE

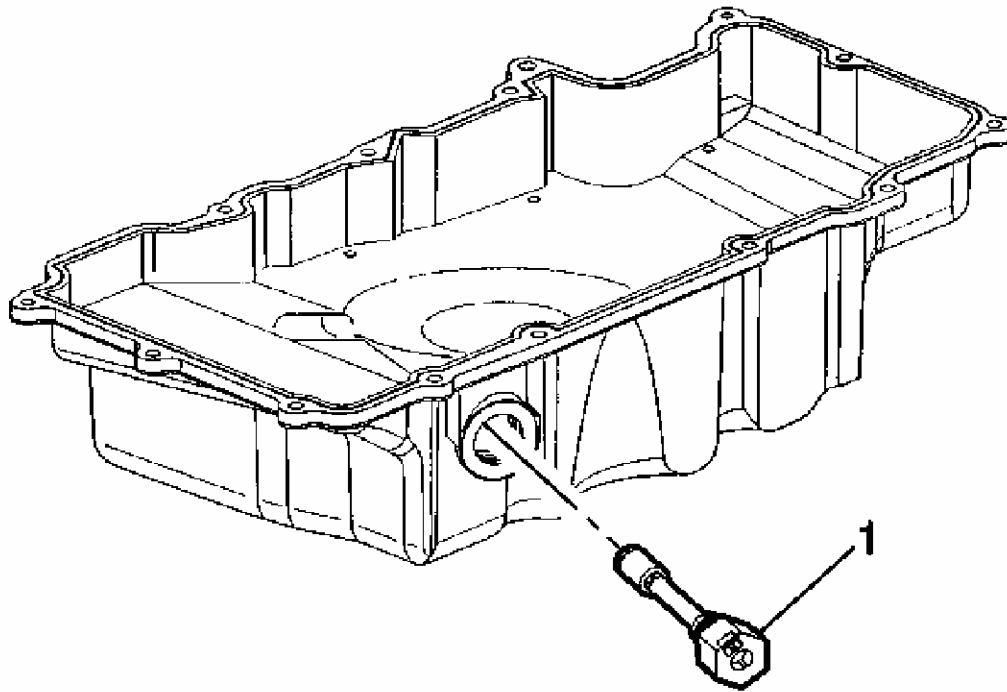


Fig. 375: Identifying Oil Level Sensor
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

1. Install the oil level sensor (1), if necessary.

Tighten: Tighten the sensor to 20 N.m (15 lb ft).

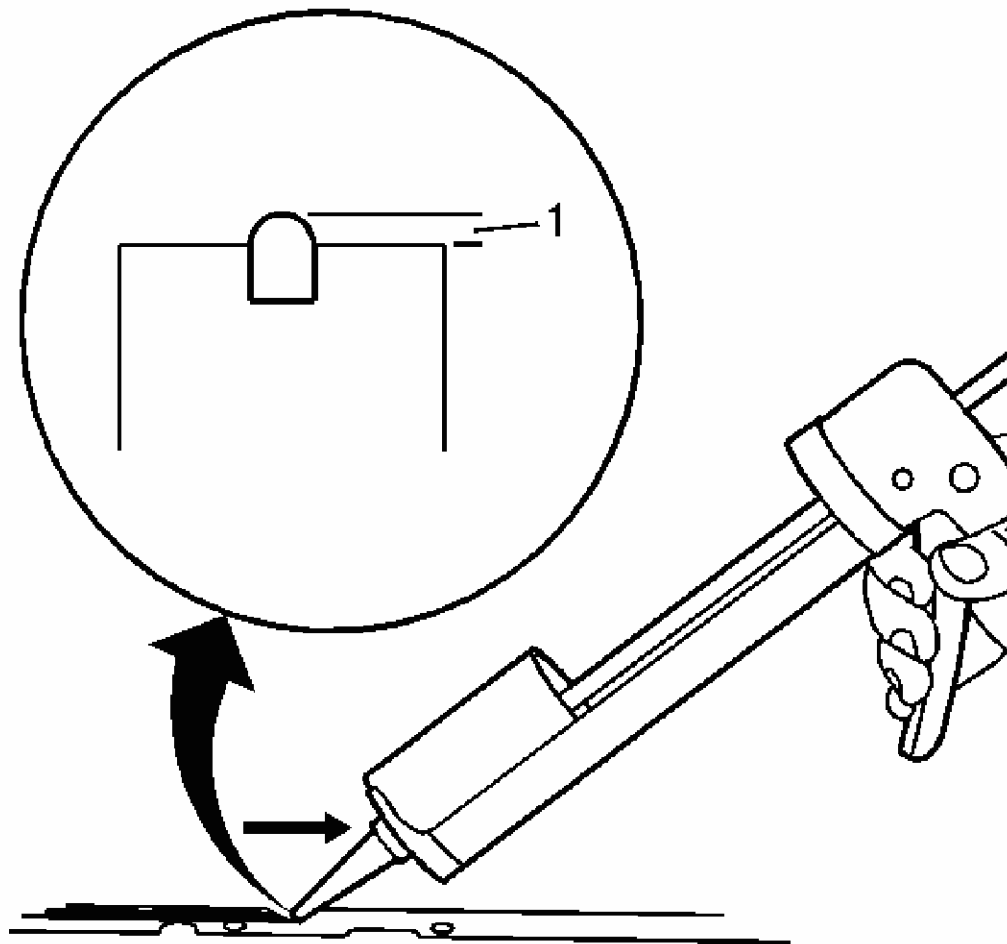


Fig. 376: Applying RTV Sealant
Courtesy of GENERAL MOTORS CORP.

2. Completely fill and slightly overfill the oil pan seal groove with a continuous bead of RTV sealant. Refer to **Sealers, Adhesives and Lubricants** for the correct part number.
3. Ensure the RTV sealant is higher than the oil pan sealing surface (1) by 3 mm (0.118 in).

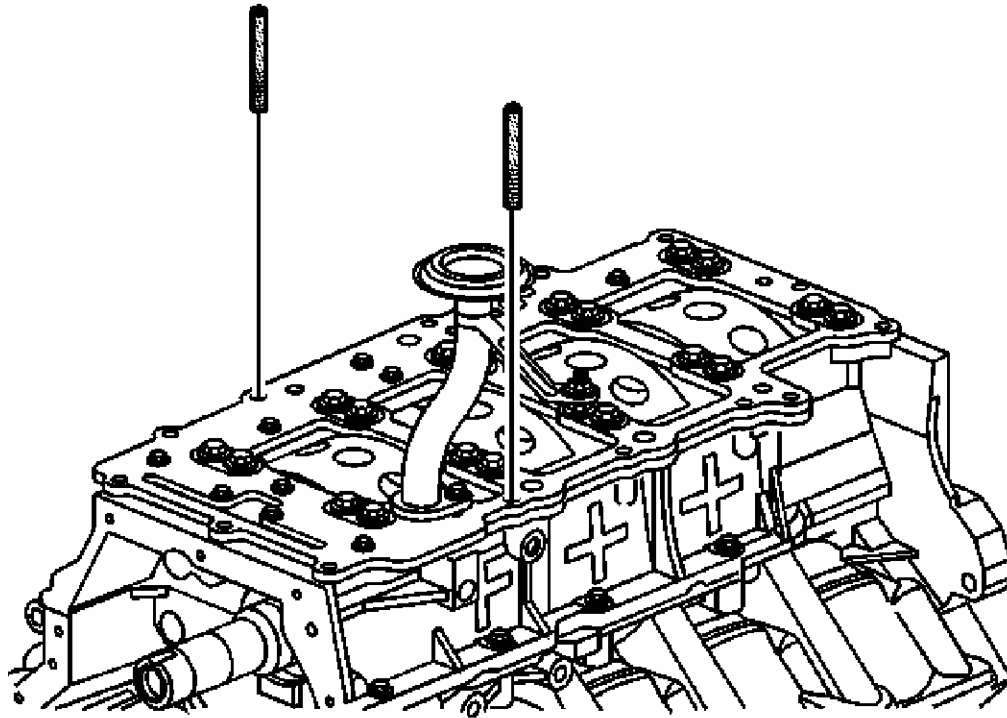


Fig. 377: Identifying EN 46109 Guide Pins
Courtesy of GENERAL MOTORS CORP.

4. To prevent shifting of the oil pan, install one **EN 46109** into the bolt hole in each side of the lower crankcase. See **Special Tools** .

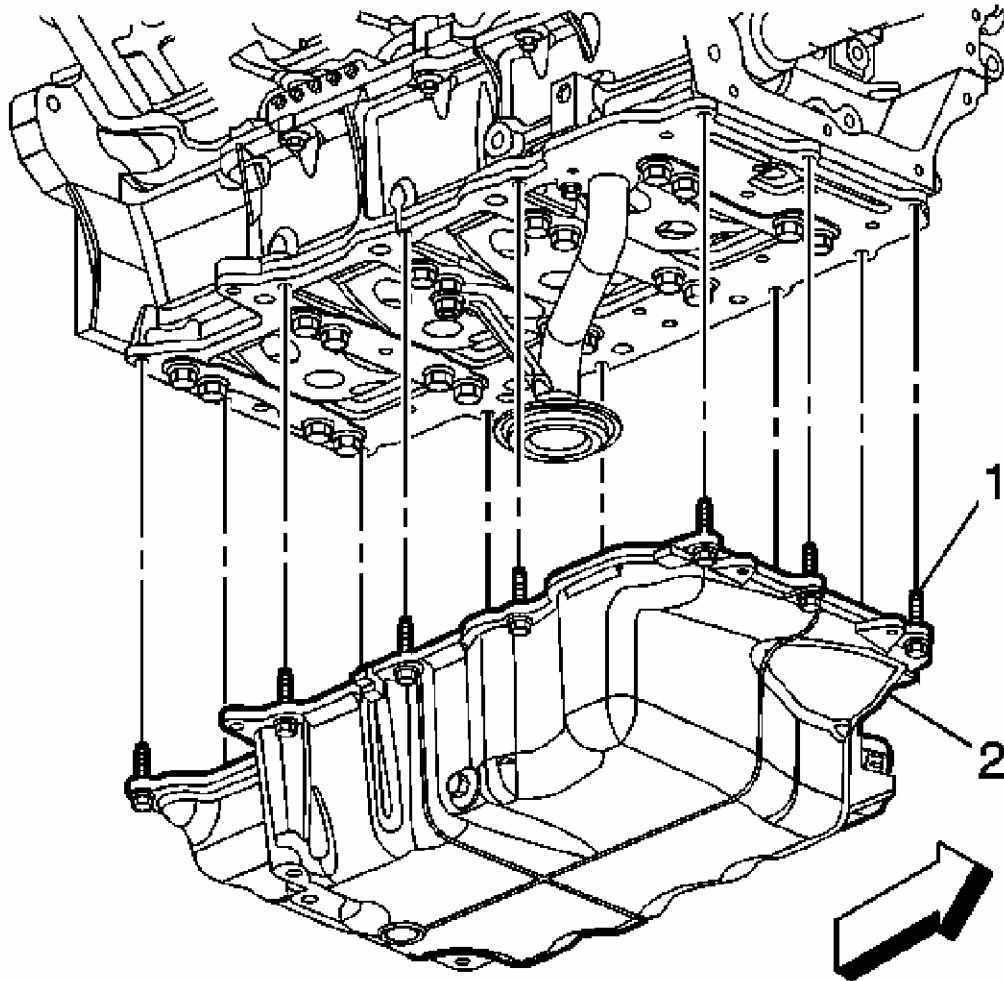


Fig. 378: View Of Oil Pan

Courtesy of GENERAL MOTORS CORP.

5. Position the oil pan (2) to the lower crankcase and finger start the oil pan bolts (1).

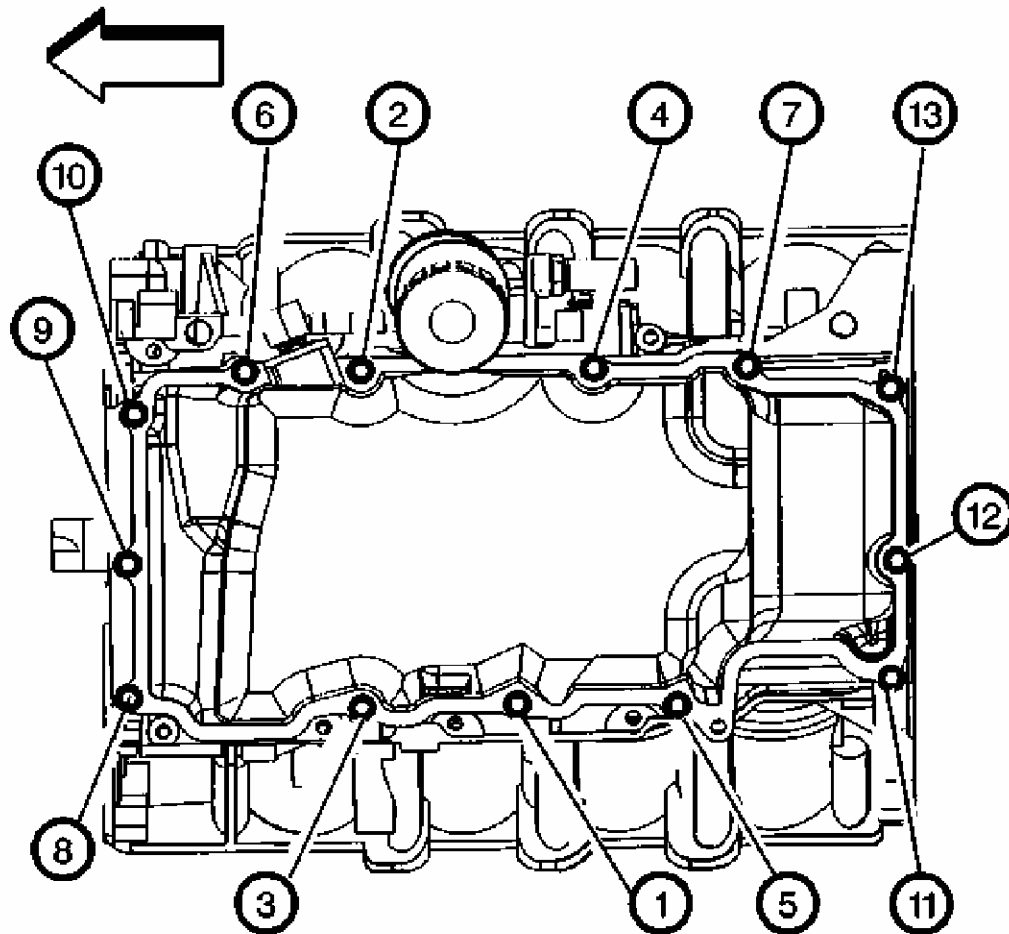


Fig. 379: Identifying Oil Pan Bolts Tightening Sequence
 Courtesy of GENERAL MOTORS CORP.

6. Tighten the oil pan bolts.

Tighten:

1. Tighten the bolts a first pass to 8 N.m (71 lb in).
2. Tighten the bolts a final pass to 12 N.m (106 lb in).

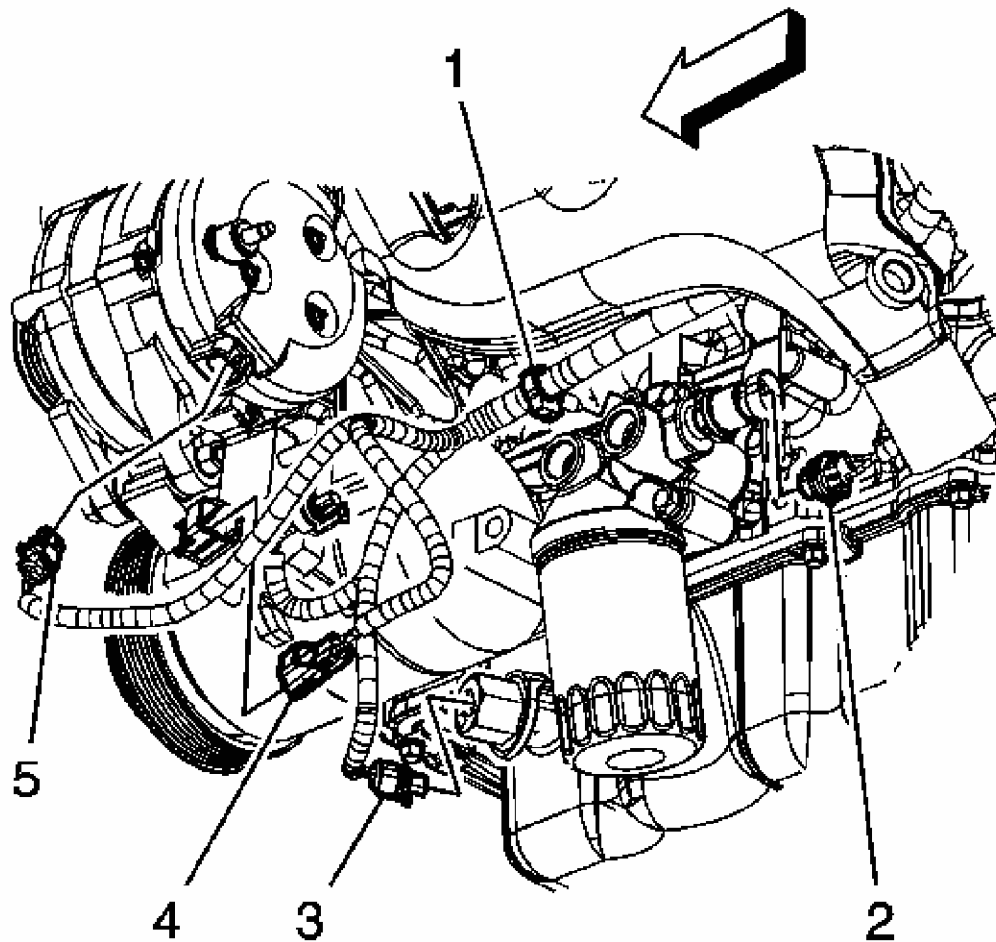


Fig. 380: Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

7. Connect the engine harness electrical connector (2) to the oil level sensor.
8. Install the front exhaust manifold pipe. Refer to **Exhaust Manifold Front Pipe Replacement (RPO LD8)**
9. Fill the engine oil. Refer to **Engine Oil and Oil Filter Replacement**

2006 Buick Lucerne CXS

2006 ENGINE Engine Mechanical - 4.6L (1 Of 5) - Lucerne

2006 Buick Lucerne CXS

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2006 ENGINE Engine Mechanical - 4.6L (1 Of 5) - Lucerne

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